DIRECT Distances to Nearby Galaxies Using Detached Eclipsing Binaries and Cepheids. VIII. Additional Variables in the Field M33B Discovered with Image Subtraction[1]

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ABSTRACT

DIRECT is a project to obtain directly the distances to two Local Group galaxies, M31 and M33, which occupy a crucial position near the bottom of the cosmological distance ladder.

As the first step of the DIRECT project we have searched for detached eclipsing binaries (DEBs) and new Cepheids in the M31 and M33 galaxies with 1m-class telescopes. In this eighth paper we present a catalog of variable stars discovered in the data from the followup observations of DEB system D33J013337.0+303032.8 in field M33B $[(\alpha, \delta) = (23^{\circ}\!.48, 30^{\circ}\!.57), \mathrm{J}2000.0]$, collected with the Kitt Peak National Observatory 2.1m telescope. In our search covering an area of $108'^2$ we have found 895 variable stars: 96 eclipsing binaries, 349 Cepheids, and 450 other periodic, possible long period or non-periodic variables. Of these variables 612 are newly discovered. Their light curves were extracted using the ISIS image subtraction package. For 77% of the variables we present light curves in standard V and B magnitudes, with the remaining 23% expressed in units of differential flux.

We have discovered a population of first overtone Cepheid candidates and for six of them we present strong arguments in favor of this interpretation.

The catalog of variables, as well as their photometry (about 9.2×10^4 BV measurements) and finding charts, is available electronically via `anonymous ftp` and the `World Wide Web`. The complete set of the CCD frames is available upon request.

Subject headings: binaries: eclipsing – Cepheids – distance scale – galaxies: individual (M33) – stars: variables: other

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[1]Based on observations obtained with the 2.1m telescope at the Kitt Peak National Observatory.

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1. Introduction

Starting in 1996 we undertook a long term project, DIRECT (i.e. "direct distances"), to obtain the distances to two important galaxies in the cosmological distance ladder, M31 and M33. These "direct" distances will be obtained by determining the distance of Cepheids using the Baade-Wesselink method and by measuring the absolute distance to detached eclipsing binaries (DEBs). While the cosmological distance scale has been the subject of numerous recent observation campaigns, especially those enabled by the Hubble Space Telescope (HST) and massive variability studies of the Magellanic clouds, M33 has not been re-surveyed since the photographic survey of Kinman, Mould & Wood (1987).

M31 and M33 are the stepping stones to most of our current effort to understand the evolving universe at large scales. First, they are essential to the calibration of the extragalactic distance scale. Second, they constrain population synthesis models for early galaxy formation and evolution and provide the stellar luminosity calibration. There is one simple requirement for all this—accurate distances. These distances are now known to no better than 10-15%, as there are discrepancies of $0.2 - 0.3$ mag between various distance indicators (e.g. Huterer, Sasselov & Schechter 1995; Holland 1998; Stanek & Garnavich 1998).

DEBs have the potential to establish distances to M31 and M33 with an unprecedented accuracy of better than 5% and possibly to better than 1%. Detached eclipsing binaries (for reviews see Andersen 1991; Paczyński 1997) offer a single step distance determination to nearby galaxies and may therefore provide an accurate zero point calibration of various distance indicators – a major step towards very accurate determination of the Hubble constant, presently an important but daunting problem for astrophysicists. DEBs have been recently used to obtain accurate distance estimate to the Large Magellanic Cloud (e.g. Guinan et al. 1998; Udalski et al. 1998).

The detached eclipsing binaries have yet to be used as distance indicators to M31 and M33. According to Hilditch (1996) there was only *one* eclipsing binary of any kind known in M33 (Hubble 1926). The recent availability of large-format CCD detectors and inexpensive CPUs has made it possible to organize a massive search for periodic variables, which will produce a handful of good DEB candidates. These can then be spectroscopically followed-up with the powerful new 6.5-10 meter telescopes.

The study of Cepheids in M33 has a venerable history (Hubble 1926). Freedman, Wilson & Madore (1991) obtained multi-band CCD photometry of some of the Cepheids discovered in photographic surveys, to build a period-luminosity relations in M33. However, the sparse photometry and the small sample (11 Cepheids) do not provide a good basis for obtaining direct Baade-Wesselink distances (see, e.g., Krockenberger, Sasselov & Noyes 1997) to Cepheids—the need for new digital photometry has been long overdue.

As the first step of the DIRECT project we have searched for DEBs and new Cepheids in the M31 and M33 galaxies. We have analyzed five $11' \times 11'$ fields in M31, A-D and F (Kaluzny et al.

1998, 1999; Mochejska et al. 1999; Stanek et al. 1998, 1999; hereafter Papers I, IV, V, II, III). A total of 410 variables, mostly new, were found: 48 eclipsing binaries, 206 Cepheids and 156 other periodic, possible long-period or non-periodic variables. We have analyzed two fields in M33, A and B (Macri et al. 2001a; hereafter Paper VI) and found 544 variables: 47 eclipsing binaries, 251 Cepheids and 246 other variables.

As a second step, we started followup observations of selected DEBs in both the M31 and M33 galaxies with larger telescopes in order to construct more precise and well sampled light curves for them. As a by-product of the monitoring of DEB system D33J013346.2+304439.9 with the Kitt Peak National Observatory 2.1m telescope, we have extracted 434 variable stars in field M33A: 63 eclipsing binaries, 305 Cepheids, and 66 other variables, of which 280 were newly discovered (Mochejska et al. 2001; hereafter Paper VII). We have also discovered eight bona fide first-overtone Cepheid candidates.

In this paper, eighth in the series, we present a catalog of variable stars found in the same field as the detached eclipsing binary D33J013337.0+303032.8 using followup observations collected at the Kitt Peak National Observatory 2.1m telescope. The paper is organized as follows: Section 2 provides a description of the observations. The data reduction procedure is outlined in Section 3. The catalog of variable stars is presented in Section 4, followed by its brief discussion in Section 5. Section 6 deals with the first overtone Cepheid candidates. The concluding remarks are stated in Section 7.

2. Observations

The data discussed in this paper was obtained at the Kitt Peak National Observatory[3] 2.1m telescope equipped with a Tektronix 2048×2048 CCD (T2KA camera) having a pixel scale $0.305''/pixel$ during two separate runs, from September 29th to October 5th, 1999 and from November 1st to 7th, 1999. The primary observing targets were three detached eclipsing binaries, one in each of the fields M33A, M33B and M31A, discovered previously as part of the DIRECT project (Papers VI and II). For field M33B we collected $74 \times 600s$ exposures in the V filter and $30 \times 600s$ in the B filter.[4] The exposure times varied slightly to compensate for the changes of seeing conditions. The typical seeing was $1''.5$. The field was observed through airmass ranging from 1 to 1.9, with the average at 1.2. The completeness of our data starts to drop rapidly at about 21.2 mag in V and 21.8 mag in B, judging from the magnitude distributions of the variable

[3] Kitt Peak National Observatory is a division of NOAO, which are operated by the Association of Universities for Research in Astronomy, Inc. under cooperative agreement with the National Science Foundation.

[4] The complete list of exposures for this field and related data files are available through `anonymous ftp` on `cfa-ftp.harvard.edu`, in `pub/kstanek/DIRECT` directory. Please retrieve the `README` file for instructions. Additional information on the DIRECT project is available through the `WWW` at `http://cfa-www.harvard.edu/~kstanek/DIRECT/`.

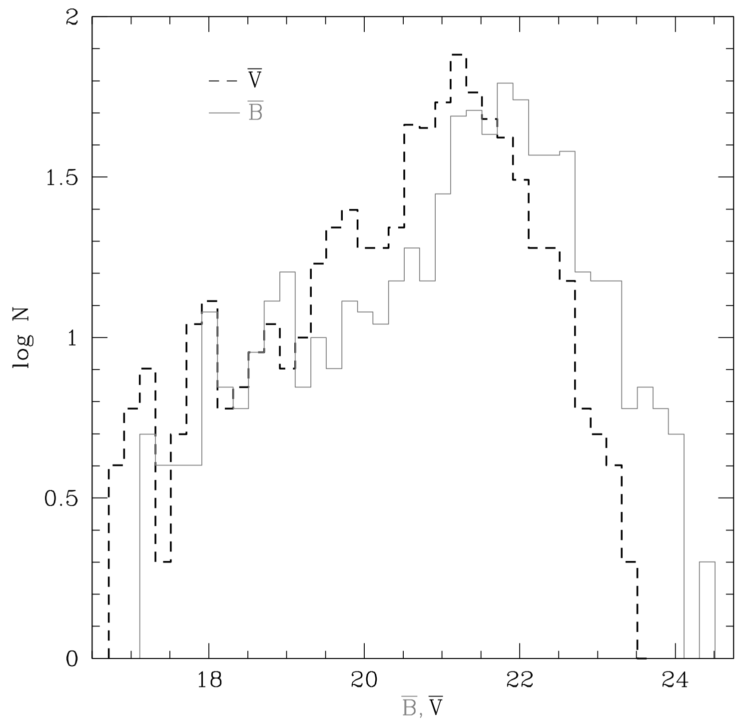

Fig. 1.— Distributions in B (continuous line) and V (dashed line) of variable stars in the field M33B.

stars (Fig. 1).

3. Data Reduction, Calibration and Astrometry

During the second night of the first observing run we found that the camera had a non-linear response. The data was corrected for this effect using the method described in Paper VII.

The photometry for the variable stars was extracted using the ISIS image subtraction package (Alard & Lupton 1998, Alard 2000a) from the V and B-band data. We followed the same reduction procedure as described in detail in Paper VII. One difference is that instead of the ISIS CZERNY subroutine for preliminary period determination we used a program based on the multiharmonic analysis of variance algorithm (Schwarzenberg-Czerny 1996).

Due to residual non-linearity, our photometry could not be calibrated from observations of standard stars. The coefficients for the color terms of the transformation were derived from the comparison of our NGC 6791 photometry with the data from the KPNO 0.9m telescope (Kaluzny & Udalski 1992). The offsets were determined relative to 735 stars above $V = 20$ mag from the DIRECT catalog of stellar objects in M33 (Macri et al. 2001b). The following transformations

were adopted:

$$v = V - 5.501 + 0.039 \cdot (B - V)$$
$$b - v = 0.146 + 0.927 \cdot (B - V)$$
$$b = B - 5.355 - 0.034 \cdot (B - V)$$

The instrumental V and B-band light curves of the variables were transformed to the standard system by adding the appropriate offsets, as the coefficients next to the color terms are very small.

Equatorial coordinates were determined for the V template star list, expanded with the variables with no V-band photometry. The transformation from rectangular to equatorial coordinates was derived using 894 transformation stars with $V < 19.5$ from the DIRECT catalog of stellar objects in M33 (Macri et al. 2001b). The average difference between the catalog and the computed coordinates for the transformation stars was $0.''06$ in right ascension and $0.''06$ in declination.

4. Catalog of Variables

4.1. Classification

The variables we are most interested in are Cepheids and eclipsing binaries (EBs). We therefore searched our sample of variable stars primarily for these two classes of variables. The variable stars were preliminarily classified as eclipsing, Cepheid or miscellaneous by visual inspection, based on the shape of their light curves. The variables for which neither V nor B-band magnitude could be determined (with only flux light curves or having periods in excess of 14 days) were not reclassified further.

In order to obtain as clean a sample of Cepheids as possible, we have inspected the location of the Cepheid variable candidates on a $V/B-V$ CMD. All of the Cepheid candidates having highly discrepant colors were reclassified as other periodic variables. The candidates with light curves in only one of the bands were checked on the period-luminosity relation for that band. Extreme outliers were also moved to the other periodic variable category.

The EBs with light curves expressed in magnitudes for at least one band, were fitted with a model described in Papers I and II. Within our assumption the light curve of an EB is determined by nine parameters: the period, the zero point of the phase, the eccentricity, the longitude of periastron, the radii of the two stars relative to the binary separation, the inclination angle, the fraction of light coming from the bigger star and the uneclipsed magnitude. Eclipsing binary candidates for which a satisfactory fit was not achieved, were reclassified as other periodic variables.

In the following sections 4.2-4.5 we present the parameters and light curves for the 895

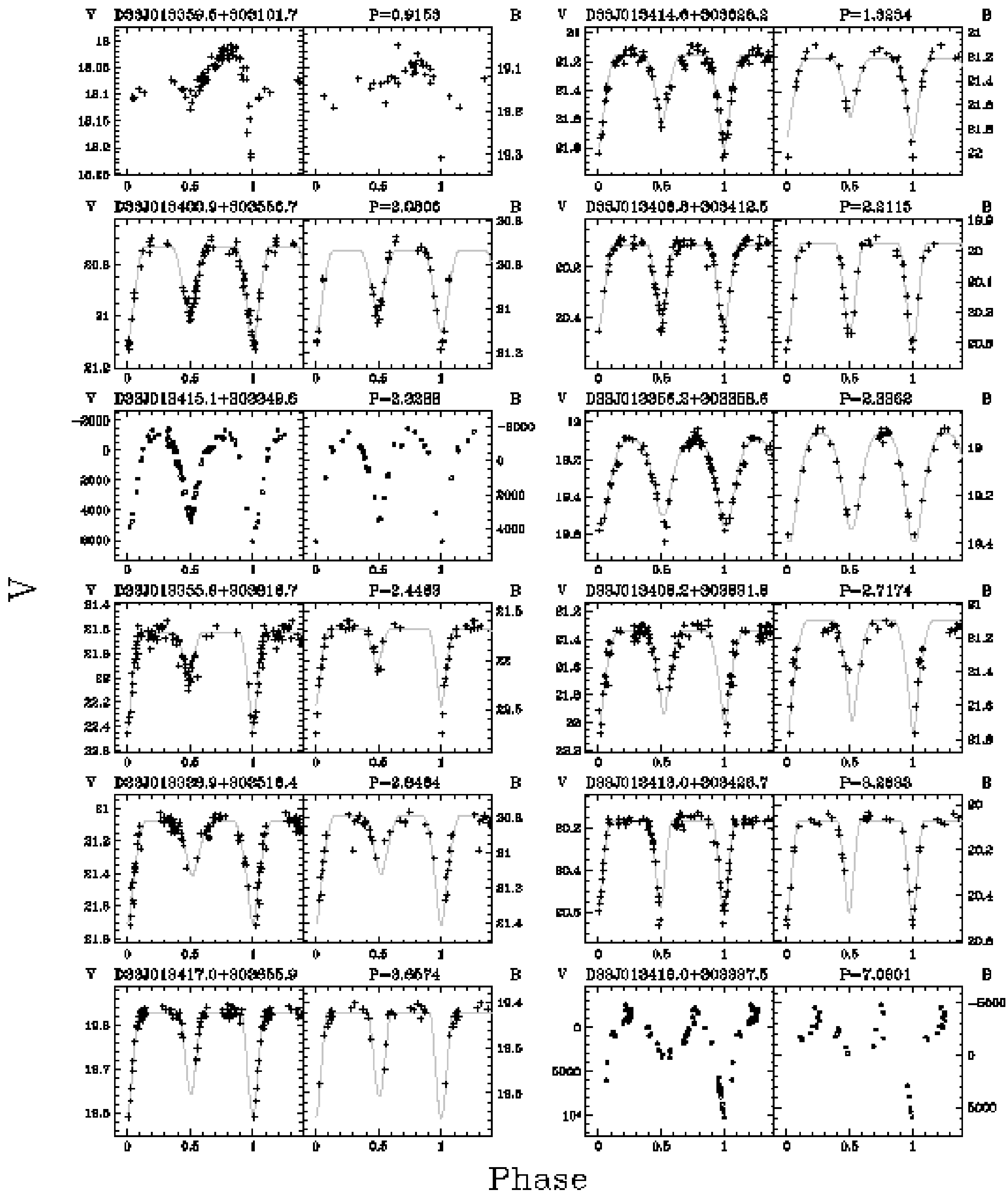

Fig. 2.— Selected BV light curves of eclipsing binaries found in the field M33B. The points on the light curves expressed in magnitudes are marked with crosses, the flux ones by open circles. The thin continuous line represents the best fit model for each star and photometric band.

identified variable stars.[5] All tables are sorted by increasing period, unless otherwise noted. Variables for which more than one plausible period was found are indicated by colons appended to their listed periods. We adopt a naming convention after Macri et al. (2001a) based on the J2000.0 equatorial coordinates, in the format: D33J*hhmmss.s*+*ddmmss.s*. The first three fields (*hhmmss.s*) correspond to right ascension expressed in hours, the last three (*ddmmss.s*) to declination, expressed in degrees, separated by the declination sign. As none of the newly discovered variables are present in previous variable star catalogs, we refer the reader to Tables 5 and 6 in Paper VI for cross-identifications.

4.2. Eclipsing Binaries

We have found a total of 96 eclipsing binaries in field M33B. In Table 1 we present the parameters for the 89 EBs with a magnitude light curve in at least one band. For each variable we list its name, period P, magnitudes V_{max} and B_{max} of the system outside of the eclipse, and the radii of the binary components R_1, R_2 in the units of the orbital separation. We also give the inclination angle of the binary orbit to the line of sight i and the eccentricity of the orbit e. The reader should bear in mind that the values of V_{max}, B_{max}, R_1, R_2, i and e are derived with a straightforward model of the eclipsing system, so they should be treated only as reasonable estimates of the "true" value. Table 2 lists seven EBs with flux light curves only. For each variable we give its name and period P. Figure 2 presents the phased light curves of 12 sample EBs (see also Table 3).

4.3. Cepheids

A total of 349 Cepheid variables were found in field M33B. In Table 4 we present 292 Cepheids with a magnitude light curve in at least one band. For each variable, we list its name, period P, flux-weighted average magnitudes $\langle V \rangle$ and $\langle B \rangle$ and the V and B-band amplitudes A_V and A_B. Due to the short time base of our observations, reliable flux-weighted magnitudes could only be determined for variables with periods shorter than 14 days.

We have extracted light curves for 37 Cepheids with longer periods, all of them identified previously in Paper VI and made them available via `anonymous ftp`. In Table 5 we list 20 Cepheids with flux light curves only. For each variable we list its name and period P. Figure 3 presents the phased light curves of 12 sample Cepheids (see also Table 6).

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[5]The BV photometry and V finding charts for all variables are available from the authors via the `anonymous ftp` from the Harvard-Smithsonian Center for Astrophysics and can be also accessed through the `World Wide Web`.

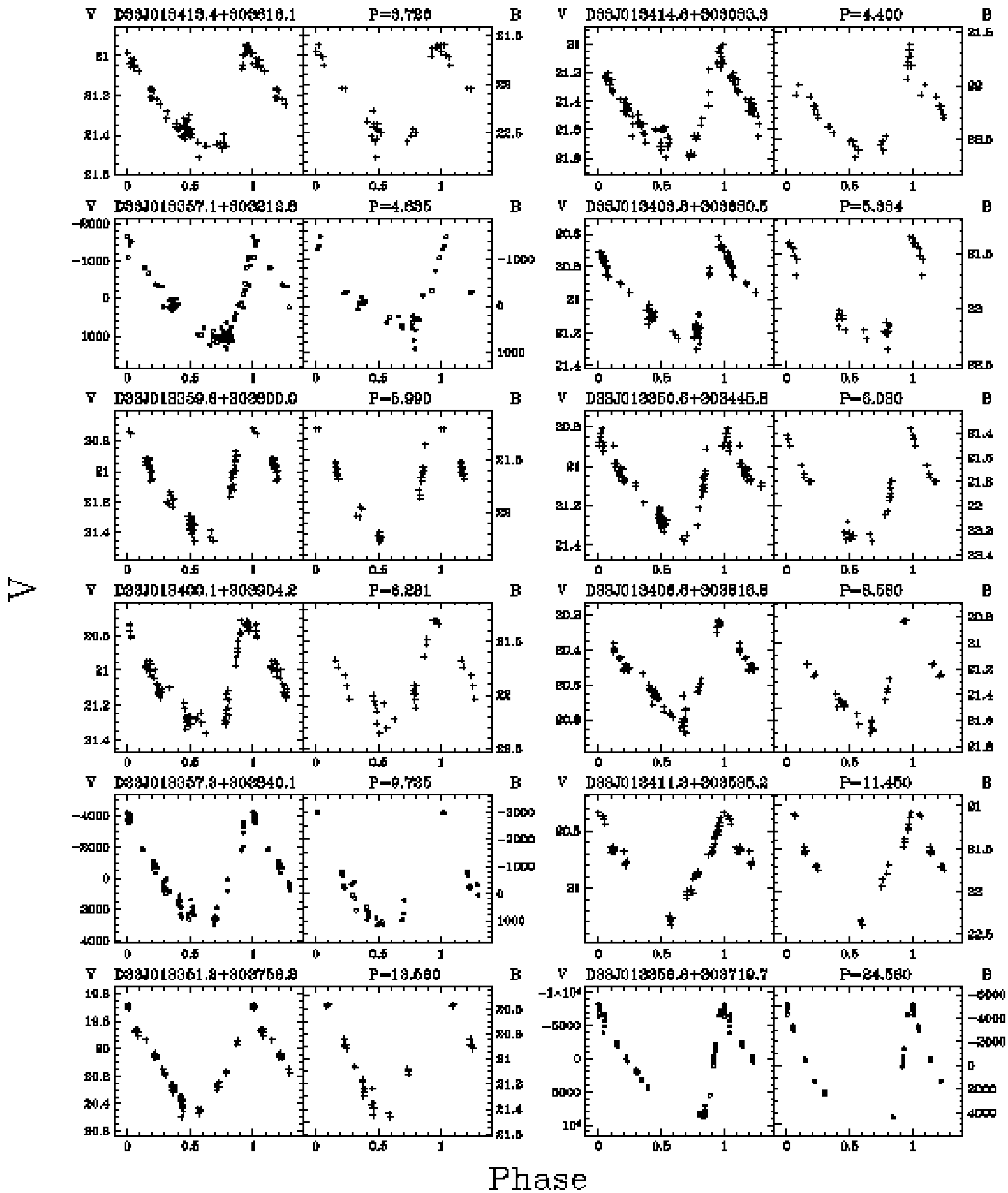

Fig. 3.— Same as Fig. 2, but for Cepheid variables.

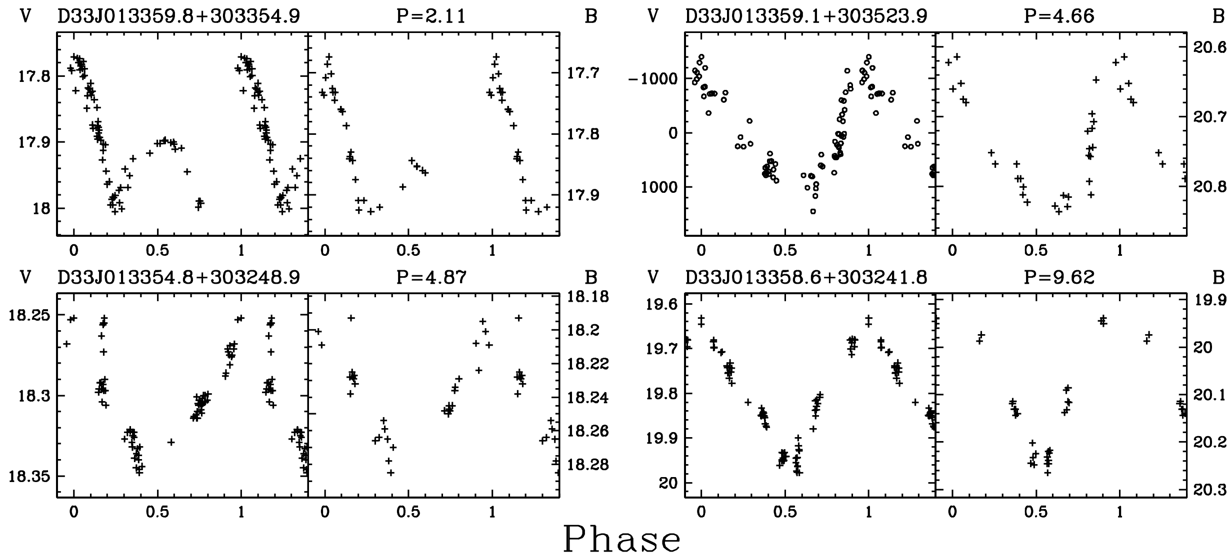

Fig. 4.— Same as Fig. 2, but for other periodic variables.

4.4. Other Periodic Variables

In Table 7 we present the parameters of 30 periodic variables. For each variable we list its name, period P, the magnitudes V and B and the V and B-band amplitudes A_V and A_B. The V and B columns list the magnitudes outside of the eclipses V_{max} and B_{max} for the eclipsing variables and flux-weighted average magnitudes $\langle V \rangle$ and $\langle B \rangle$ for the other variables. We have also found 29 other variables with periods of the order of 50-100 days (identified previously in Paper VI), which we do not list in the table. Their light curves are available via `anonymous ftp`. In Table 8 we list the light curves of all periodic variables. Figure 4 presents the phased light curves of 4 sample other periodic variables.

4.5. Miscellaneous Variables

In Table 9 we present the parameters of 391 miscellaneous variables. For each variable we list its name, the average magnitudes $\bar{V}$ and $\bar{B}$ and the V and B-band amplitudes A_V and A_B. About 25% of those variables are most likely periodic, with periods in excess of 14 days. In Table 10 we list the light curves of all miscellaneous variables. Figure 5 presents the light curves of four sample miscellaneous variables.

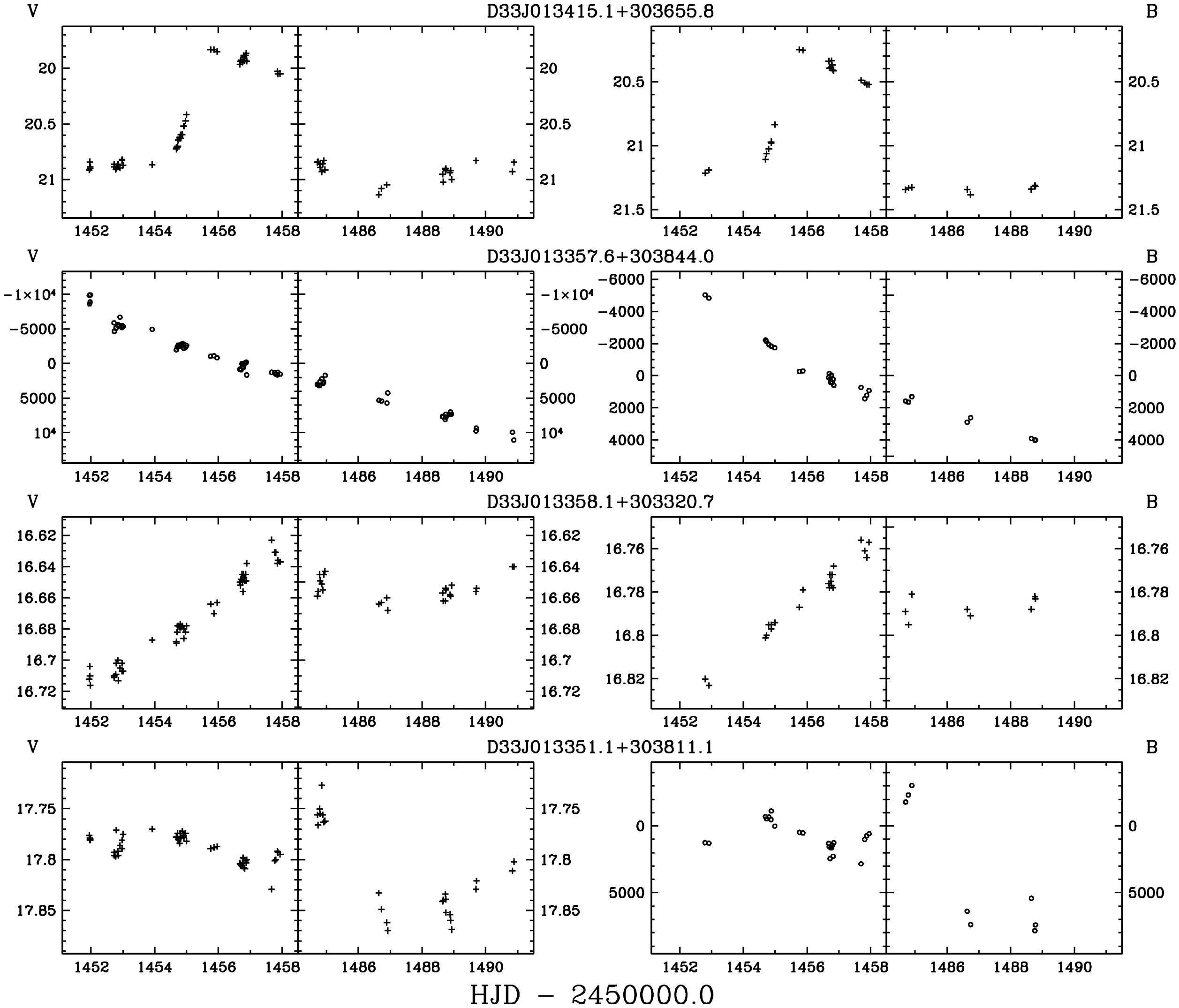

Fig. 5.— Same as Fig. 2, but for miscellaneous variables.

4.6. Comparison with the catalog in Paper VI

In Figure 6 we compare our V and/or B photometry for 23 EBs (squares), 76 Cepheids (open circles) and periodic variables (filled circles) with the values listed in the DIRECT catalog of variables in M33 (Paper VI). As reference we plot in the background similar comparisons for all the stars in the field (dots). The variables, with some exceptions, have ΔB and ΔV distributions roughly similar to the rest of the stars, although they do show a slight tendency to be fainter in our catalog. This trend is especially prominent in the V-band for the EBs, but is absent in their B-band comparison. There are also a few faint Cepheids, which show unusually large differences in photometry, of the order of 0.6-0.8 mag. In paper VII we have inspected the light curves of several such variables in both catalogs (see Fig. 8 therein). It seems that these discrepancies are caused in large part by the fact that fixed position photometry is prone to identify and fit a profile

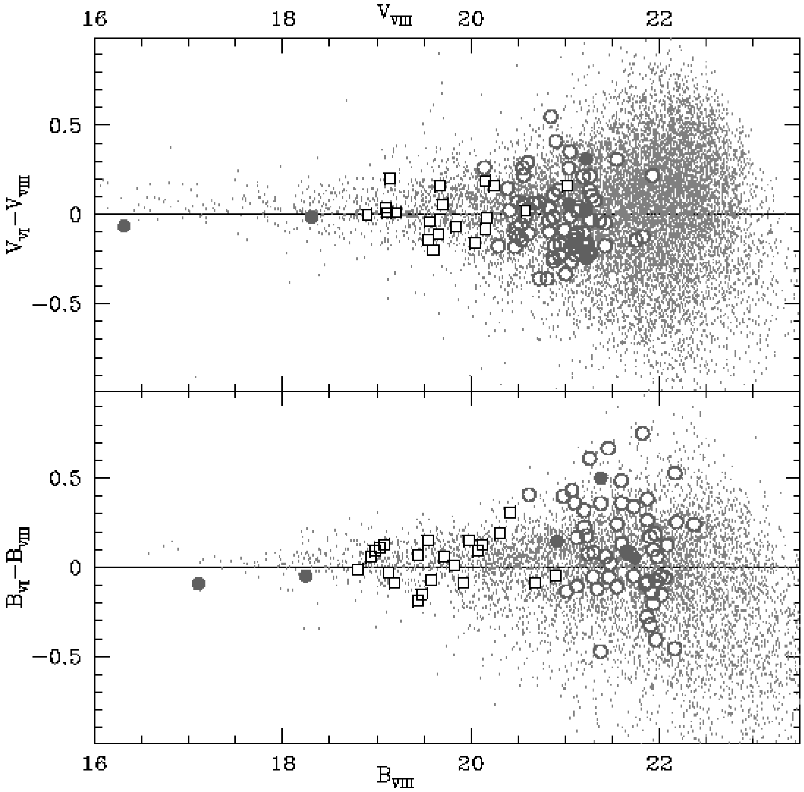

Fig. 6.— A comparison between variable star photometry in the V (upper panel) and B-band (lower panel) between our catalog and Paper VI. EBs are denoted by squares and Cepheids by circles. All other stars in the field are plotted with small dots in the background for reference.

at the supplied position even when the star is below the detection threshold, resulting in the false measurement of a fainter magnitude.

In Figure 7 we plot a histogram of the surface density of Cepheids (N/kpc^2) as a function of their period, assuming a distance of 840 kpc to M33 (Freedman, Wilson & Madore 1991). The solid line represents all Cepheids from our catalog with $P < 14$ days, the dashed line – the Cepheids from Paper VI. The areas covered in this search and in Paper VI are 108 and 222 arcmin^2. As our observations were carried out during two one-week runs spaced one month apart, we lack the baseline to detect long period Cepheids. Since our data were collected with an instrument 2.6 times larger in area and with better seeing, we have a higher detection rate for short period Cepheids. The Paper VI catalog, due to the much longer baseline of observations, contains more long period Cepheids.

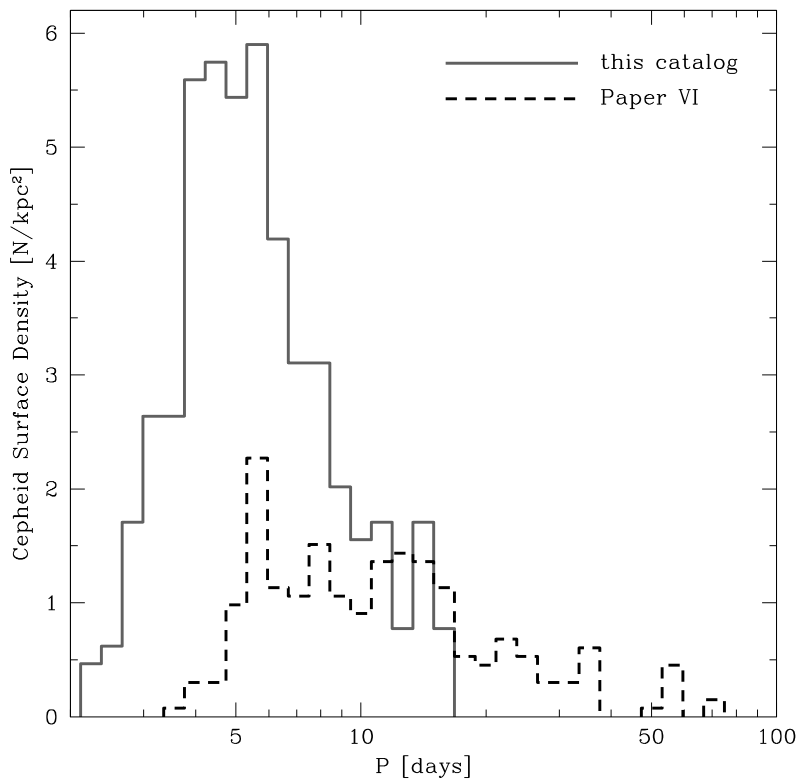

Fig. 7.— A histogram of the surface density of Cepheids (N/arcmin^2) as a function of their period. The solid line represents all Cepheids from our catalog with $P < 14$ days, the dashed line – the Cepheids from Paper VI.

5. Discussion

In Fig. 8 we plot the positions of the variable stars on the $V/B-V$ CMD. The EBs are denoted by open squares and Cepheids by filled circles in the left panel, the periodic variables by open squares and miscellaneous by filled circles in the right panel.

All but a few of the EBs occupy the upper main sequence. Several fall in the region occupied by Cepheids. An inspection of their light curves confirmed that these variables are most likely genuine EBs, and not Cepheids phased with twice their period. These variables may be suffering from higher than average reddening or from blending with red stars. One of the EBs, D33J013359.5+303101.7, with $V = 18.05$ and $B-V = 1.06$, is located clearly apart from the rest. The light curve of this variable is shown in Fig. 2 without the model overlaid, for clarity. The lack of a fairly constant maximum light between the eclipses indicates that it is a contact binary. The brightness of the system between the secondary eclipse and the primary shows a slower rise and a steeper decline. The light curve between the primary eclipse and the secondary is more sparsely sampled, so we have checked it in our earlier data (Paper VI), and it seems to be more symmetric and of fainter maximum brightness. Its location in the CMD suggests that it may be

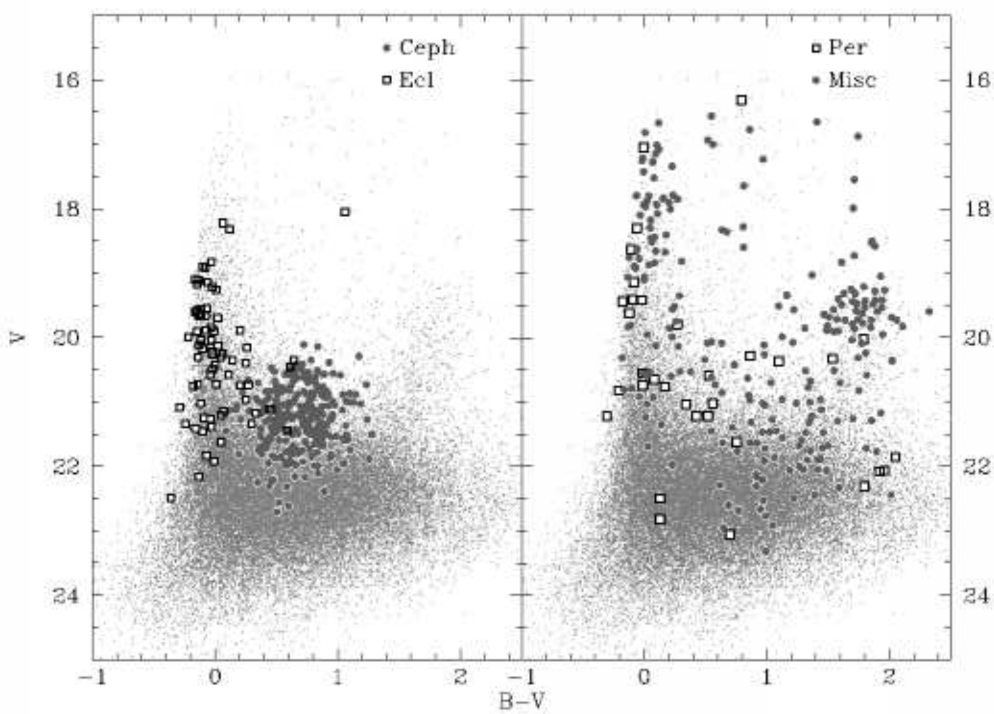

Fig. 8.— The $V/B-V$ CMD for the variable stars in field M33B. The EBs (open squares) and Cepheids (filled circles) are shown in the left panel, periodic (filled squares) and miscellaneous variables (open circles) in the right panel.

a foreground object. A similar variable was found by Mochejska & Kaluzny (1999) in NGC 7789 (V4), displaying strong asymmetry of the light outside of the eclipses.

Most Cepheids occupy the region between $0.4 < B-V < 1$, with several outliers stretching from $B-V = 0$ to $B-V = 1.2$. The discrepant colors of some of the Cepheid variables are most likely caused by blending with nearby bright stars of very different colors and/or by reddening. The phenomenon of blending occurs when the Cepheid possesses one or more close companions which cannot be separated at the resolving power of the instrument used. A further discussion of blending and its properties can be found in Mochejska et al. (2000; 2001) and Stanek & Udalski (1999).

The other periodic variables are located all over the CMD. Most of them seem to be pulsating variables. One of them, D33J013359.8+303354.9, exhibits variability of an unclear nature. It is located on the upper main sequence, with $V = 17.89$ and $B-V = -0.08$. Its light curve (Fig. 7) shows two maxima of unequal brightness with sharp minima in between, reminiscent of eclipses. This behavior is confirmed in our earlier data (Paper VI).

The miscellaneous variables are also spread throughout the CMD, with concentrations on the upper main sequence and the upper red giant branch (RGB). Very few of the newly discovered variables are redder than $B-V = 1.5$. Most of the variables classified as long period are located

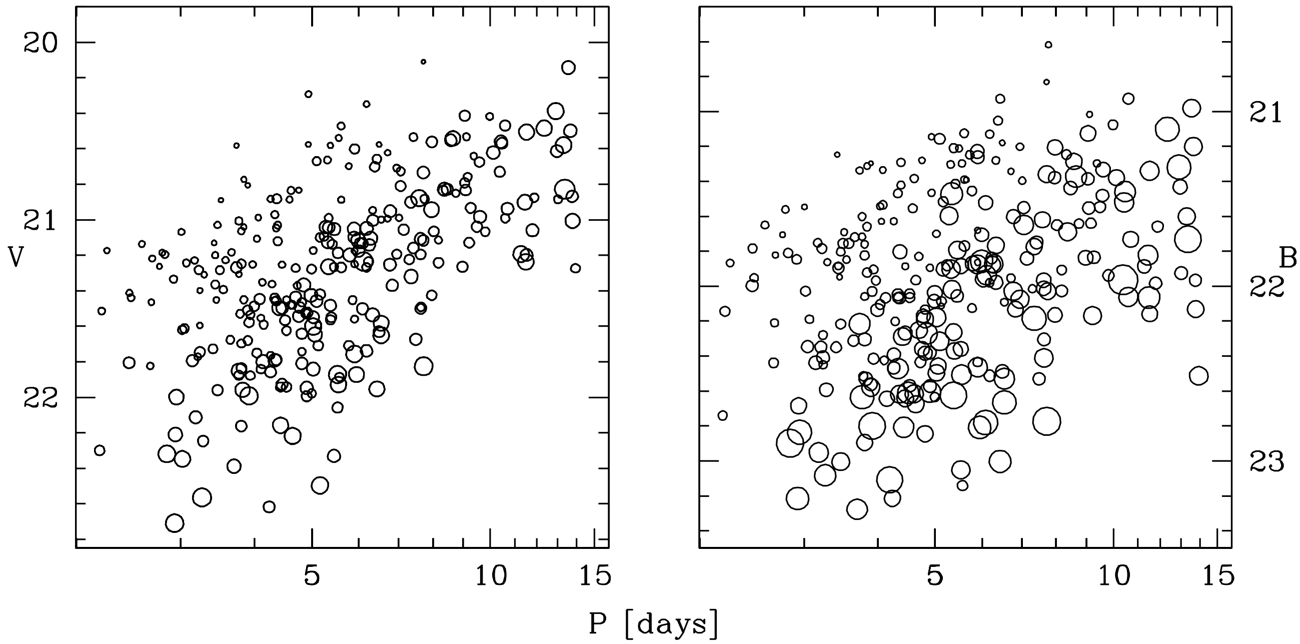

Fig. 9.— The V and B-band Period-Luminosity diagrams for the Cepheids in field M33B. The circles are proportional in size to their amplitudes in the corresponding band.

on the upper main sequence. Several exhibit colors similar to Cepheids, but are much brighter. It is likely that some of these variables are Cepheids with periods in excess of 14 days.

In Figure 9 we present the B and V-band P-L diagrams for the Cepheid variables, drawn as open circles proportional in size to their amplitudes. As expected, the amplitudes in the B-band are on average larger than in V. A clear relation between the period and magnitude is discernible. Several Cepheids too faint for their periods are probably suffering from greater than average reddening. Some of the faintest Cepheids exhibit quite large amplitudes. This is not a physical effect and is most likely caused by a similar phenomenon to the one discussed in Subsection 4.6 regarding the comparison with Paper VI photometry. If the magnitude used to convert the light curve from flux to magnitudes is measured too faint, the resulting amplitude will be too large.

For periods shorter than seven days the relations widen upwards considerably, with the brighter Cepheids for a given period having smaller amplitudes. One possibility is that these Cepheids are pulsating in the first overtone. We have already found a population of such stars in Paper VII, with eight very promising candidates among them. On the other hand these could be fundamental mode Cepheids which are heavily affected by blending: adding a constant flux would tend to increase the brightness of a Cepheid and diminish its amplitude. We will examine these stars in more depth in Section 6.

Figure 10 shows the location of the EBs and Cepheids within the field M33B. The Cepheids are plotted as open circles, proportional in size to their period and the EBs as open squares. To

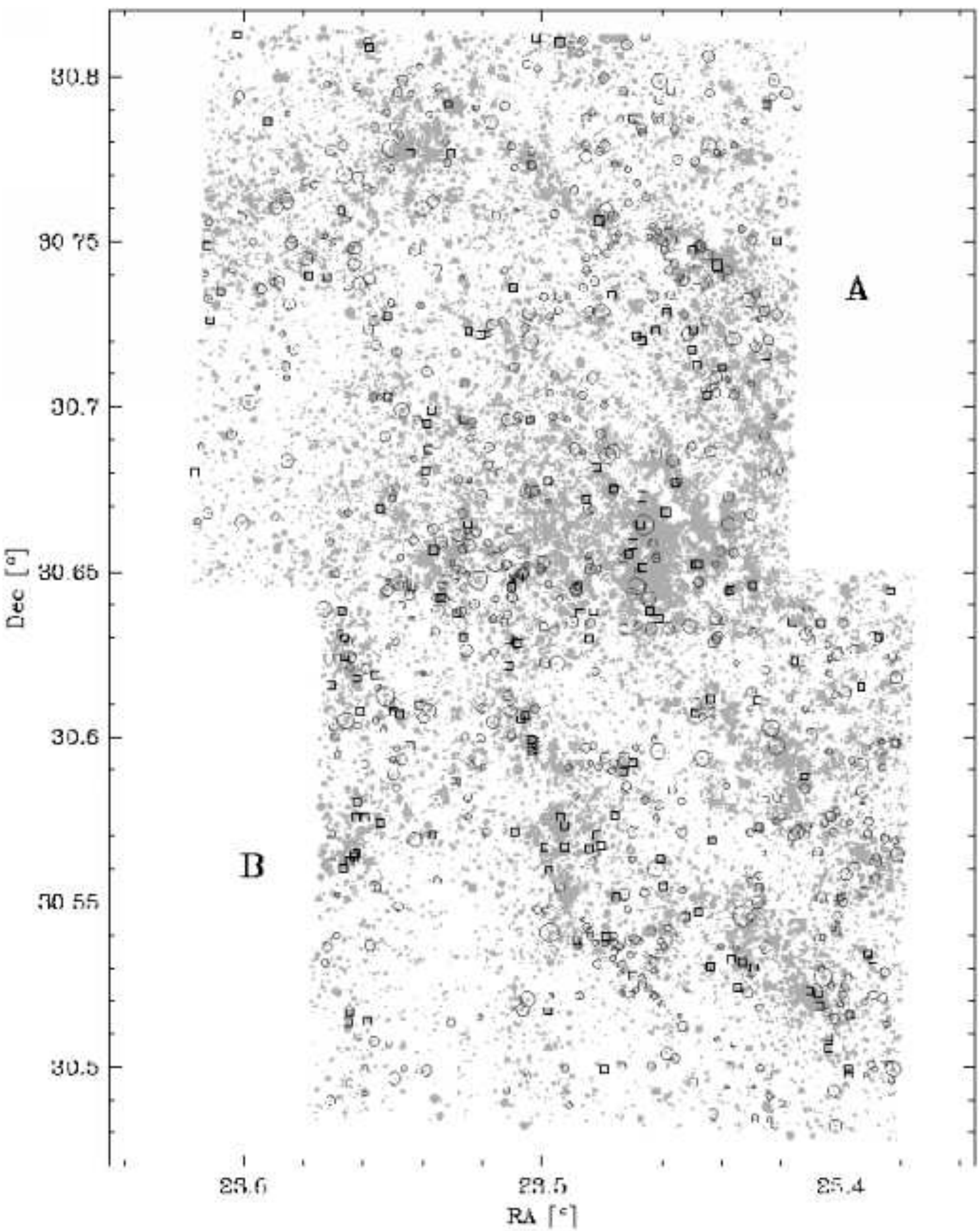

Fig. 10.— The location of EBs (squares) and Cepheids (circles) in the fields M33A (top) and M33B (bottom). The size of the Cepheid symbols are proportional to their period. All other stars in the field with $V < 21.5$ mag are drawn as dots of size proportional to their magnitude.

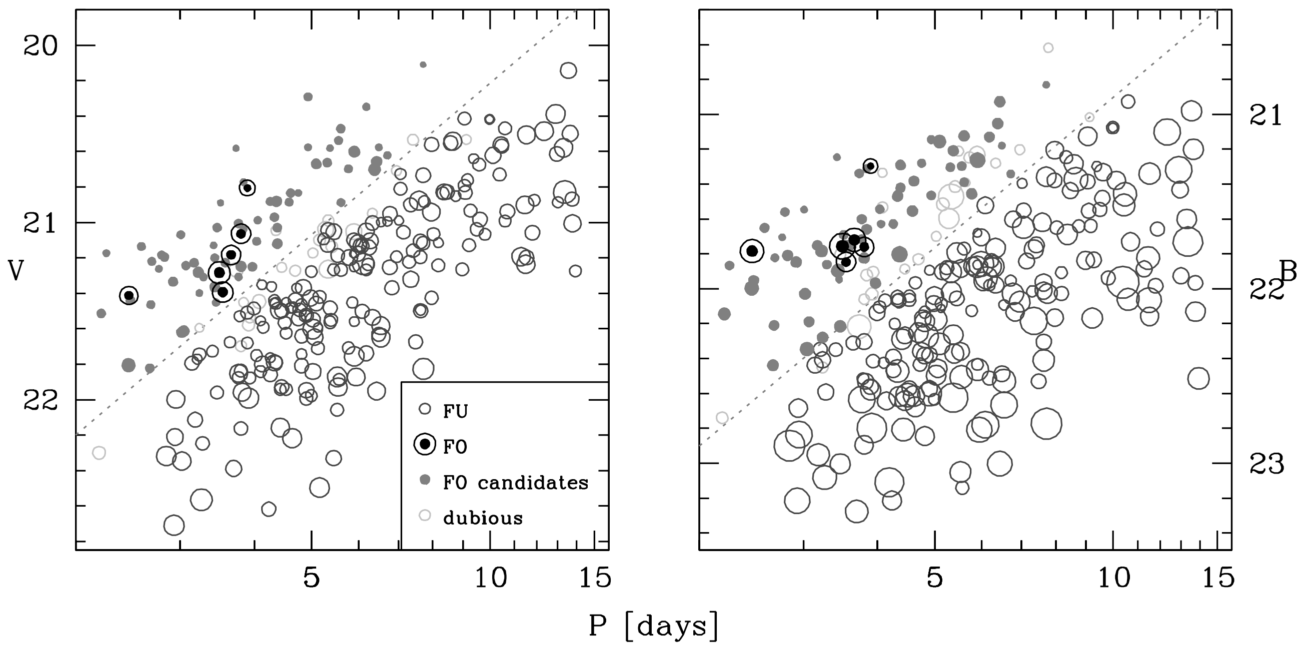

Fig. 11.— The V and B-band Period-Luminosity diagrams for the Cepheids in field M33B. The circles are proportional in size to the pulsational amplitudes of the Cepheids in the corresponding band. The dotted lines show the division between FU (open circles) and FO (filled circles) Cepheids. The encircled dots represent the most reliable FO Cepheid candidates. The light open circles show the Cepheids which are above the line in one band only.

trace the spiral pattern of the galaxy we plot in the background all the stars with $V < 21.5$ mag as filled dots of size proportional to their magnitude. These two types of variables appear somewhat more plentiful within the spiral arms.

6. First Overtone Cepheids

As we have noted in the previous Section, on the B and V-band P-L diagrams in Fig. 9 there are Cepheids which seem too bright for their periods. In addition they possess smaller pulsational amplitudes of variability compared to the normal Cepheids. Their positions on the P-L diagrams would lead us to expect that these should be first overtone (FO) pulsators (as in Fig. 2 of Udalski et al. 1999; hereafter U99). The situation is, however, complicated by the existence of blending. As a result of blending the Cepheid should appear brighter because of the added constant flux and its amplitude, measured in magnitudes, should decrease (Mochejska et al. 2000, 2001; Stanek & Udalski 1999).

In order to try to determine whether these Cepheids are first overtone pulsators, we have checked whether they possess other properties expected of such stars. In addition to being

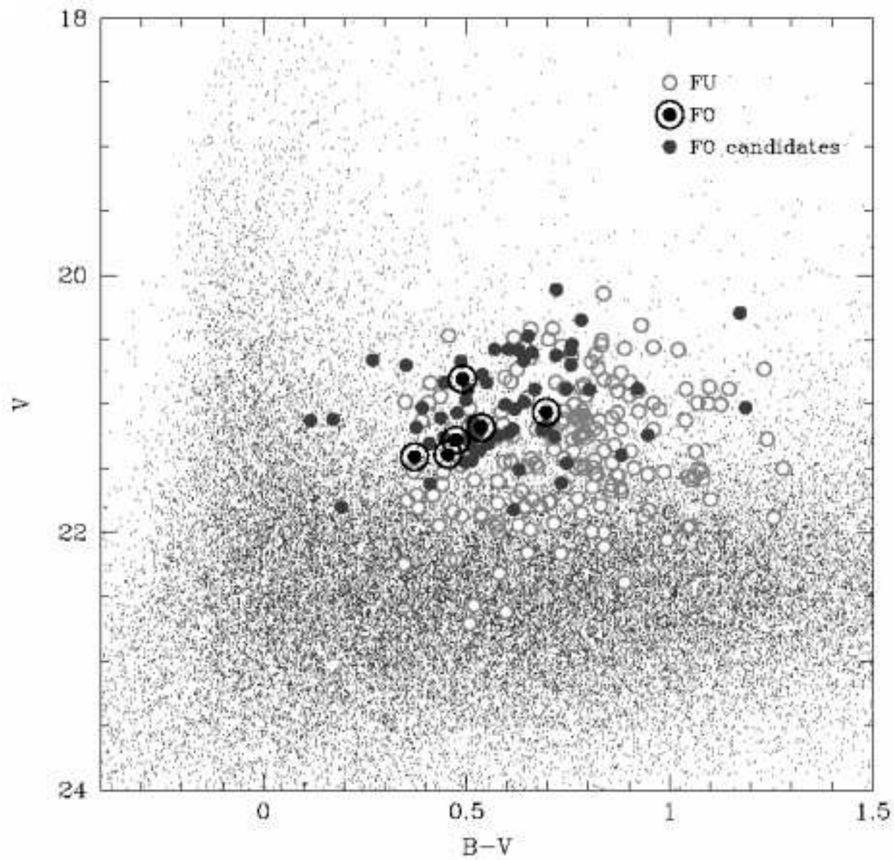

Fig. 12.— The $V/B-V$ CMD for the Cepheid variables. The FU Cepheids are denoted by open circles and the FO ones by filled circles. The encircled dots represent the most reliable FO Cepheid candidates.

brighter and having a smaller amplitude, Cepheids pulsating in the first overtone should have more symmetric (sinusoidal) light curves and be on average bluer than fundamental mode Cepheids (FU). The most powerful technique for discriminating them from FU Cepheids are the Fourier parameters of their light curves (Antonello & Aikawa 1995; Beaulieu et al. 1995).

To select a sample of FO Cepheid candidates we have made a division on the P-L diagrams roughly parallel to the P-L relation, between the bright low amplitude and fainter high amplitude Cepheids (dotted lines on Fig. 11). In our final sample we included the Cepheids which were above these lines in both of the P-L diagrams. There are 44 such Cepheids in our catalog (filled circles). FO Cepheids should have periods ranging from 1.7 to 6 days. We decided not to make a cutoff at higher periods, although we did not regard it likely that Cepheids with $P > 6$ days would turn out to be FO pulsators.

On the $V/B-V$ CMD (Fig. 12) we plot the positions of the FU Cepheids (open circles) and FO candidates (filled circles). As expected of FO Cepheids, our candidates are bluer than

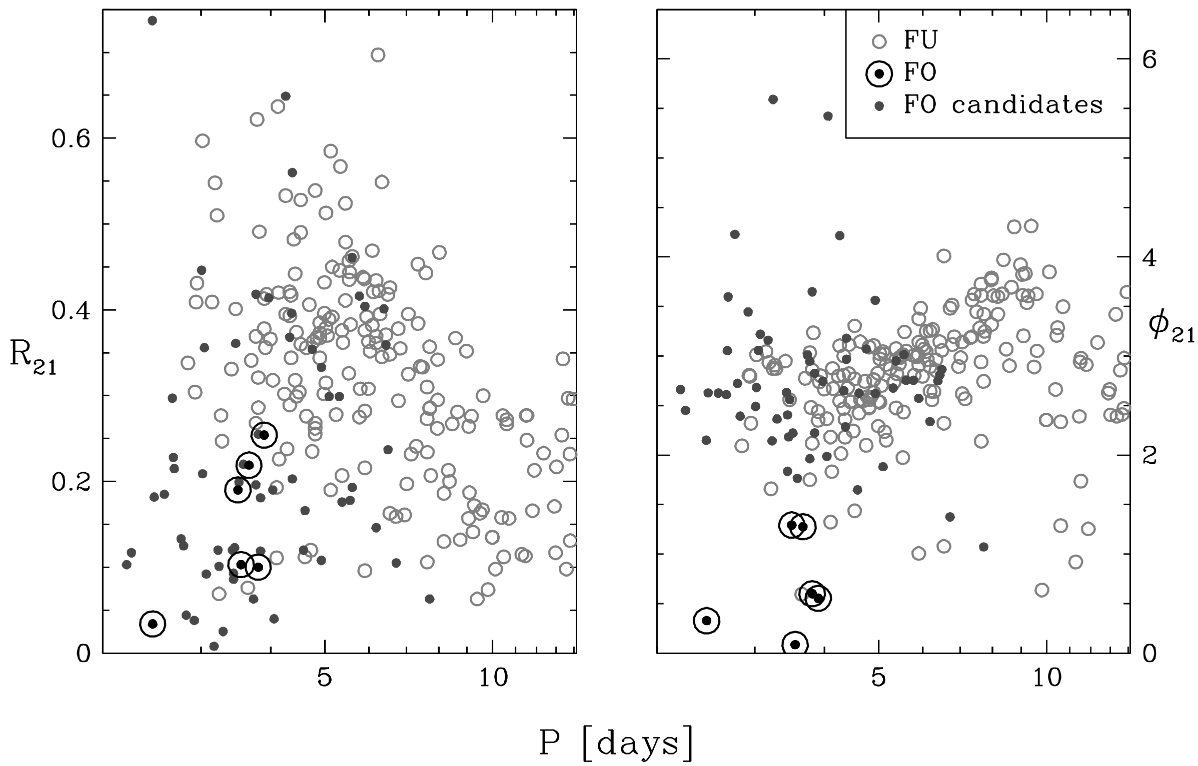

Fig. 13.— The Fourier parameters R_{21} and ϕ_{21} of the Cepheid light curves as a function of period. The FU Cepheids are denoted by open circles and the FO ones by filled circles. The encircled dots represent the most reliable FO Cepheid candidates.

the FU ones. We note that on the CMD presented by U99 for the Large Magellanic Cloud (LMC) Cepheids (Fig. 4 therein) there is also some overlap between the loci of those two types of Cepheids.

The relations between the light curve Fourier parameters $R_{21} = A_2/A_1$, $\phi_{21} = \phi_2 - 2\phi_1$ and the period for the FO Cepheid candidates (filled circles) and FU mode pulsators (open circles) are shown in Fig. 13. We have compared them with Fig. 3 in U99 for LMC Cepheids. We notice on the $R_{21}/\log P$ diagram for LMC that within our range of periods the FO Cepheids progress upwards in R_{21} with increasing period, forming the second branch of the V-shaped pattern and then merge with the FU Cepheid sequence at higher periods. The situation is very similar on the $\phi_{21}/\log P$ diagram in U99, where on the one hand the FU Cepheids are confined to a narrower sequence, but on the other there is more overlap between them and the FO pulsators.

Indeed we do observe in Fig. 13 the FO Cepheid candidates to occupy roughly the predicted positions despite our larger scatter in the Fourier parameters than in U99. From the $\phi_{21}/\log P$ diagram in the right panel we have selected six FO Cepheids which are most separated from the FU Cepheid sequence. We examined their positions on the R_{21} diagram to find that they are also rather well separated from the FU mode Cepheids. These six bona fide FO Cepheid candidates

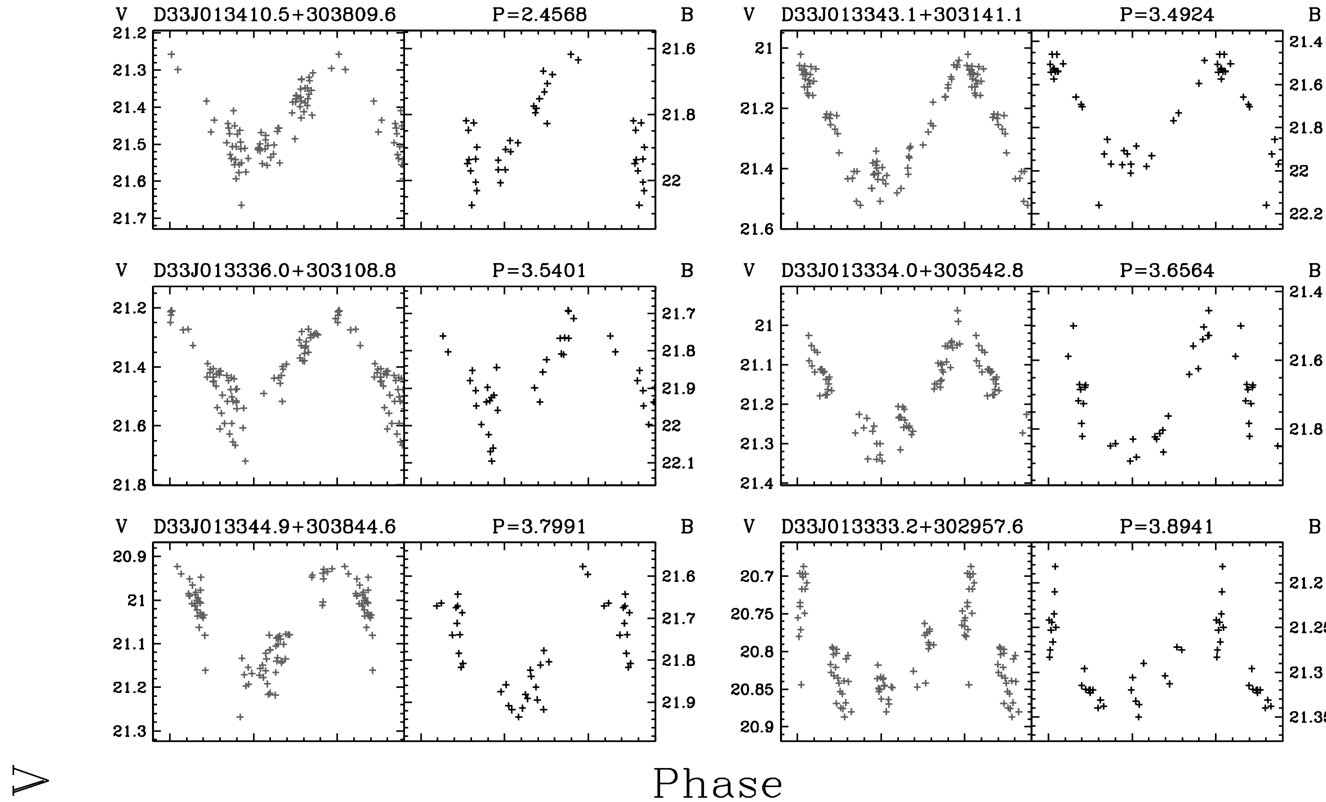

Fig. 14.— The V and B-band light curves of the six FO Cepheids in the field M33B.

are denoted by encircled dots on Figs 11-13. As for the rest of the candidates, we believe many of them may also be FO Cepheids. More accurate photometry obtained with a larger instrument would be necessary to obtain better Fourier parameters of their light curves and resolve this issue.

In Figure 14 we show the light curves of the six FO Cepheids. They appear more symmetrical in shape and do not exhibit the fast rise and slow decline typical for FU Cepheids (see Fig. 3). This fact lends further credibility to the notion that these Cepheids pulsate in the first overtone.

7. Conclusions

Our search for variable stars in the data from the followup observations of the detached eclipsing binary D33J013337.0+303032.8 in field M33B collected at the 2.1m KPNO telescope resulted in the discovery of 96 eclipsing binaries, 349 Cepheids, and 450 other periodic, possible long period or non-periodic variables. Out of the total 895 variables 612 are not listed in our other M33 catalogs (Papers VI and VII). Due to the short time base of our observations, we were limited to variables with periods not exceeding 14 days. Thanks to the use of a larger aperture instrument and a novel method of image reduction – the ISIS image subtraction package, we were more efficient at finding the fainter and lower amplitude variables than in our previous study of

this field, especially for short period Cepheids ($P < 8d$). We have also found a population of Cepheids which are most likely pulsating in the first overtone and for six of them we present strong arguments in favor of this interpretation.

The method of image subtraction has two main advantages over the classical profile fitting method. It is more efficient in discovering variables: in field M33A we have discovered 355 periodic variables using ISIS and only 212 with Dophot (Paper VII). Additionally in crowded fields image subtraction can lead to large improvements in the photometric accuracy (Alard 2000b).

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Table 1. DIRECT Eclipsing Binaries in M33B

Name	P $(days)$	V_{max}	B_{max}	R_1	R_2	i (deg)	e	Comments
D33J013359.5+303334.7	0.8682	···	20.60	0.57	0.39	55.83	0.01	
D33J013359.5+303101.7	0.9162	18.05	19.11	0.30	0.23	68.90	0.03	
D33J013350.5+303346.8	1.0757	20.43	20.43	0.62	0.37	54.02	0.03	
D33J013356.2+303748.1	1.1047:	···	21.97	0.44	0.44	76.64	0.30	
D33J013357.0+303814.4	1.1078	···	21.82	0.56	0.44	83.94	0.00	
D33J013415.8+303727.4	1.2019	20.71	···	0.49	0.30	66.69	0.00	
D33J013401.9+303741.8	1.2597	20.13	20.15	0.48	0.33	73.70	0.09	
D33J013414.6+303628.2	1.3234	21.15	21.22	0.44	0.37	85.55	0.01	
D33J013406.8+303816.2	1.3456	20.35	20.49	0.57	0.34	51.31	0.06	
D33J013415.0+303352.6	1.6468	···	19.73	0.63	0.36	51.03	0.00	
D33J013414.0+303049.8	1.6681:	20.35	20.99	0.67	0.33	46.42	0.04	
D33J013332.0+303839.2	1.6691	19.70	19.72	0.56	0.37	65.12	0.00	1
D33J013416.1+303817.2	1.6818	20.39	20.64	0.34	0.24	67.60	0.01	
D33J013354.2+303435.2	1.7433:	20.57	20.53	0.35	0.27	74.67	0.01	
D33J013410.4+303843.7	1.8115	21.83	21.76	0.36	0.27	77.67	0.01	
D33J013415.0+303431.5	1.8763	19.85	19.82	0.59	0.33	60.48	0.00	1
D33J013347.4+303249.0	1.8990	20.58	20.69	0.46	0.27	71.28	0.02	1
D33J013337.6+303803.1	1.9020	21.02	20.90	0.47	0.40	85.85	0.02	1
D33J013400.9+303556.7	2.0806	20.73	20.74	0.46	0.31	72.48	0.01	
D33J013350.2+303317.8	2.0991	20.16	20.42	0.46	0.38	85.27	0.05	1
D33J013342.6+303420.8	2.1037	20.26	20.24	0.65	0.34	49.93	0.00	
D33J013408.8+303412.5	2.2115	20.11	19.98	0.40	0.26	76.15	0.00	
D33J013415.8+303748.5	2.3258	21.46	21.36	0.47	0.32	85.75	0.01	
D33J013415.1+303349.6	2.3288	···	19.74	0.47	0.35	70.66	0.01	
D33J013356.2+303358.6	2.3362	19.10	18.94	0.59	0.40	80.22	0.00	1
D33J013402.2+303416.8	2.3697	19.99	19.77	0.67	0.33	53.02	0.00	
D33J013347.6+303625.8	2.3708	20.74	20.94	0.38	0.21	75.21	0.02	
D33J013402.7+303746.6	2.4162	20.74	21.01	0.25	0.18	76.76	0.00	
D33J013355.8+303816.7	2.4463	21.63	21.68	0.35	0.28	84.76	0.02	
D33J013346.5+303642.0	2.5123	19.90	19.89	0.36	0.22	65.50	0.01	
D33J013339.8+303806.0	2.5165	19.14	19.08	0.62	0.38	46.32	0.00	1
D33J013334.4+303654.9	2.5272	21.41	21.25	0.23	0.15	81.08	0.06	
D33J013408.2+303831.8	2.7174	21.34	21.10	0.44	0.39	88.66	0.03	
D33J013358.6+303431.6	2.7335	19.91	19.76	0.62	0.38	47.47	0.01	
D33J013407.0+303509.6	2.7820:	21.25	21.16	0.75	0.09	51.93	0.23	
D33J013353.4+303522.6	2.7995	20.49	20.47	0.40	0.26	72.40	0.02	
D33J013359.8+303359.7	2.8392	20.76	20.58	0.40	0.33	80.08	0.07	
D33J013338.9+303516.4	2.8464	21.08	20.79	0.43	0.38	80.26	0.03	
D33J013355.3+303401.8	2.8856	22.49	22.13	0.61	0.38	88.63	0.00	
D33J013414.3+303432.5	2.8878	20.81	···	0.46	0.28	62.85	0.05	
D33J013352.0+303905.0	2.9592	···	19.12	0.59	0.40	86.71	0.01	1

Table 1—Continued

Name	P ($days$)	V_{max}	B_{max}	R_1	R_2	i (deg)	e	Comments
D33J013335.4+302952.3	2.9756	···	19.97	0.37	0.26	66.84	0.10	
D33J013333.8+303203.1	3.0504	20.68	···	0.60	0.40	49.83	0.02	
D33J013342.6+303640.3	3.0562	21.45	22.04	0.42	0.28	63.56	0.03	
D33J013350.7+303808.4	3.0632	19.89	19.81	0.63	0.36	61.79	0.00	
D33J013337.9+303120.7	3.0678	19.55	19.48	0.57	0.42	61.66	0.03	1
D33J013344.7+303157.4	3.0931	21.27	21.23	0.37	0.17	68.61	0.16	
D33J013351.4+303817.0	3.0968:	···	19.84	0.35	0.27	89.71	0.08	
D33J013346.4+303407.6	3.1525	19.56	19.44	0.61	0.36	72.76	0.03	1
D33J013337.7+303106.2	3.1855	···	18.75	0.63	0.22	40.42	0.16	
D33J013335.3+302958.0	3.2232	20.31	20.17	0.34	0.24	68.77	0.17	
D33J013413.0+303426.7	3.2633	20.17	20.07	0.32	0.23	82.42	0.01	1
D33J013344.3+303127.0	3.3001	20.72	20.58	0.55	0.44	89.06	0.07	
D33J013343.9+303155.1	3.3293	19.17	19.02	0.69	0.31	50.69	0.07	
D33J013415.5+303344.7	3.3570	···	19.61	0.55	0.33	52.34	0.00	
D33J013335.3+303057.5	3.4769	20.96	21.21	0.63	0.34	45.80	0.01	
D33J013415.7+303047.8	3.5157:	19.26	19.27	0.71	0.28	50.19	0.01	
D33J013339.7+303722.1	3.5808	22.16	22.03	0.31	0.26	85.77	0.00	
D33J013417.0+303655.9	3.6574	19.57	19.42	0.38	0.21	74.77	0.01	
D33J013413.3+303707.7	3.6863	19.89	20.09	0.53	0.33	57.40	0.01	
D33J013346.5+303150.0	3.7427	21.92	21.91	0.44	0.40	80.84	0.04	
D33J013400.9+303545.1	3.8955	20.16	20.12	0.47	0.47	72.50	0.01	1
D33J013358.1+303400.2	4.0523	19.66	19.58	0.63	0.35	43.29	0.00	1
D33J013415.4+303100.6	4.5675	18.91	18.83	0.25	0.14	75.57	0.02	
D33J013331.6+303554.2	4.7624	21.21	21.26	0.43	0.31	72.88	0.03	
D33J013357.2+303219.0	4.9380	19.11	18.98	0.51	0.49	47.80	0.01	1
D33J013355.1+302957.4	5.0920	20.04	19.92	0.36	0.22	77.50	0.08	1
D33J013352.6+303138.7	5.1492	21.17	21.50	0.67	0.33	58.36	0.03	
D33J013411.9+303628.0	5.2239	20.25	20.31	0.39	0.29	72.97	0.02	1
D33J013358.1+303424.3	5.3011	19.64	19.52	0.57	0.43	44.09	0.03	
D33J013342.5+303314.4	5.3325	···	18.79	0.30	0.23	66.81	0.09	1
D33J013338.5+303124.2	5.5371	18.90	18.80	0.50	0.45	50.32	0.03	1
D33J013352.7+303532.3	5.5966	···	19.98	0.54	0.41	67.15	0.02	1
D33J013348.5+303243.7	6.0990	21.34	21.64	0.29	0.28	79.84	0.17	
D33J013337.0+303032.8	6.1626	19.60	19.44	0.19	0.14	79.50	0.23	1
D33J013401.7+303619.9	6.2788:	···	19.10	0.63	0.26	44.99	0.06	
D33J013410.7+303550.1	6.3837	20.30	20.35	0.59	0.40	56.66	0.01	
D33J013402.7+303718.2	6.4280	20.46	21.07	0.30	0.30	71.48	0.22	
D33J013343.0+303149.1	6.4993	20.22	20.20	0.61	0.39	52.56	0.04	
D33J013333.4+303159.2	6.5015	21.12	21.57	0.60	0.40	58.45	0.00	
D33J013354.8+303222.6	6.6518:	18.22	18.28	0.71	0.29	51.12	0.08	
D33J013333.0+303749.8	6.6860	20.04	20.01	0.38	0.25	67.31	0.07	

Table 1—Continued

Name	P $(days)$	V_{max}	B_{max}	R_1	R_2	i (deg)	e	Comments
D33J013406.4+303749.6	7.0058	18.82	18.79	0.29	0.19	65.50	0.05	
D33J013344.8+303839.4	7.1830	···	19.81	0.44	0.39	64.07	0.02	
D33J013355.6+303412.8	7.4391	19.67	19.54	0.24	0.18	78.19	0.15	1
D33J013354.0+303304.5	8.7761	···	19.03	0.48	0.36	72.21	0.01	1
D33J013336.9+303019.8	9.0223	19.21	19.19	0.67	0.33	60.10	0.07	1
D33J013409.8+303634.6	9.2676	21.39	21.36	0.27	0.22	89.09	0.01	
D33J013411.5+303625.4	9.8310	18.32	18.44	0.68	0.31	45.79	0.03	

Note. — (1) Variables identified by Macri et al. (2001a)

Table 2. DIRECT Flux Eclipsing Binaries in M33B

Name	P $(days)$	Comments
D33J013414.9+303449.7	1.6767	
D33J013357.2+303846.1	2.2157	
D33J013402.4+303842.4	2.4338	
D33J013401.4+303623.5	2.5535	
D33J013343.1+303845.1	2.8873	1
D33J013414.9+303703.6	6.1083	
D33J013416.0+303337.5	7.0801	

Note. — (1) Variables identified by Macri et al. (2001a)

Table 3. LIGHT CURVES OF ECLIPSING BINARIES IN M33B

Name	Filter	HJD−2451000	mag	σ_{mag}
D33J013408.2+303831.8	B	452.7982	21.353	0.027
	B	452.9166	21.214	0.033
	B	454.6968	21.172	0.025
	B	454.7299	21.153	0.019

Note. — Table 3 is available in its entirety in the electronic version of the Astronomical Journal. A portion is shown here for guidance regarding its form and content.

Table 4. DIRECT Cepheids in M33B

Name	P (*days*)	$\langle V\rangle$	$\langle B\rangle$	A_V	A_B	Comments
D33J013414.2+303000.0	2.188:	22.30	22.74	0.23	0.20	
D33J013348.4+303124.1	2.206	21.51	22.14	0.14	0.23	
D33J013334.3+303448.0	2.251:	21.17	21.87	0.09	0.15	
D33J013412.4+303850.9	2.454	21.80	22.00	0.27	0.30	
D33J013410.5+303809.6	2.457	21.41	21.78	0.12	0.20	
D33J013353.7+303143.5	2.472	21.44	21.95	0.14	0.18	
D33J013353.6+303120.9	2.579	21.14	21.65	0.11	0.16	
D33J013344.7+303024.6	2.665:	21.82	22.44	0.13	0.22	
D33J013356.7+303241.1	2.676	21.46	22.21	0.11	0.17	
D33J013343.0+302938.5	2.686	21.22	21.82	0.11	0.11	
D33J013345.2+302938.5	2.762	21.26	21.70	0.08	0.09	
D33J013416.5+303307.2	2.791	21.18	21.56	0.11	0.14	
D33J013405.6+303536.8	2.822	21.20	21.81	0.14	0.21	
D33J013336.9+303725.8	2.842	22.32	22.90	0.46	0.81	
D33J013406.0+303857.9	2.917	21.33	21.85	0.16	0.21	
D33J013356.1+303531.2	2.928:	22.71	23.21	0.49	0.64	
D33J013416.8+303347.9	2.939	22.21	22.68	0.36	0.43	
D33J013409.6+303709.6	2.950	22.00	22.84	0.39	0.69	
D33J013348.9+303056.0	3.007:	21.07	21.55	0.12	0.09	
D33J013332.7+303555.0	3.019:	21.62	22.03	0.19	0.22	
D33J013342.2+303353.1	3.019:	22.35	···	0.43	···	
D33J013351.0+303557.7	3.042	21.61	22.35	0.20	0.30	
D33J013336.6+303230.0	3.066	21.24	22.19	0.14	0.18	
D33J013345.9+303030.3	3.140:	21.79	22.44	0.29	0.35	
D33J013412.4+303739.3	3.166	21.23	21.75	0.13	0.18	
D33J013359.4+303117.4	3.179:	22.11	22.95	0.31	0.54	
D33J013352.8+303346.1	3.205:	21.77	22.35	0.14	0.29	
D33J013412.8+303607.4	3.218	21.28	21.78	0.19	0.23	
D33J013340.0+303404.8	3.232:	21.59	22.45	0.10	0.18	
D33J013343.3+303323.5	3.232	21.40	22.28	0.08	0.19	
D33J013407.0+303850.1	3.232	21.74	22.41	0.25	0.33	
D33J013343.3+303631.0	3.259	22.56	23.08	0.51	0.60	
D33J013331.9+302945.6	3.272	22.25	22.59	0.26	0.35	
D33J013414.2+302931.2	3.286:	21.31	21.86	0.10	0.13	
D33J013345.6+303211.6	3.401:	21.73	22.35	0.20	0.26	
D33J013344.5+303209.8	3.416:	21.13	21.25	0.08	0.07	
D33J013402.9+302934.5	3.431	21.20	21.88	0.12	0.16	
D33J013405.9+303433.0	3.431	21.36	21.90	0.18	0.27	
D33J013334.1+303111.4	3.446	21.45	21.95	0.10	0.09	
D33J013336.4+303258.9	3.461:	···	21.80	···	0.18	
D33J013344.4+303720.6	3.461	21.03	22.22	0.13	0.23	

Table 4—Continued

Name	P (*days*)	$\langle V \rangle$	$\langle B \rangle$	A_V	A_B	Comments
D33J013401.1+302950.4	3.461:	21.96	23.00	0.25	0.48	
D33J013343.1+303141.1	3.492	21.28	21.76	0.18	0.23	
D33J013333.9+302951.0	3.508:	20.89	21.69	0.06	0.13	
D33J013336.0+303108.8	3.540	21.39	21.85	0.16	0.14	
D33J013404.7+303527.4	3.572	21.23	21.75	0.13	0.23	
D33J013352.5+303124.3	3.639	21.68	22.31	0.17	0.27	
D33J013334.0+303542.8	3.656	21.18	21.72	0.13	0.19	
D33J013416.5+303540.4	3.691	22.39	23.28	0.35	0.57	
D33J013352.9+303119.1	3.726	20.58	21.34	0.06	0.14	
D33J013413.4+303618.1	3.726	21.27	22.22	0.27	0.59	
D33J013350.9+303431.9	3.762	21.01	21.60	0.15	0.16	
D33J013355.7+303214.9	3.762:	21.31	21.72	0.10	0.14	
D33J013407.1+303512.4	3.762	21.85	22.64	0.40	0.67	
D33J013412.0+303535.0	3.762	21.88	···	0.22	···	
D33J013412.3+303024.4	3.781	21.53	22.52	0.17	0.20	
D33J013344.9+303844.6	3.799	21.06	21.76	0.13	0.15	
D33J013352.5+303548.0	3.799:	21.70	22.06	0.18	0.16	
D33J013405.0+303054.3	3.799	21.25	21.82	0.20	0.20	
D33J013406.5+303901.8	3.799	21.84	22.30	0.24	0.33	
D33J013411.1+302958.1	3.799:	22.16	22.89	0.26	0.43	
D33J013350.4+303108.2	3.818:	21.96	22.53	0.39	0.35	
D33J013341.2+303428.1	3.837	20.77	21.31	0.09	0.12	
D33J013341.7+302902.5	3.837	21.04	21.66	0.09	0.18	
D33J013406.9+303903.5	3.837	21.45	21.92	0.15	0.21	
D33J013333.2+302957.6	3.894:	20.81	21.30	0.07	0.05	
D33J013335.3+303427.1	3.894	21.68	22.56	0.20	0.32	
D33J013400.5+303550.2	3.894:	21.51	22.58	0.23	0.49	
D33J013359.7+303251.1	3.914:	21.58	22.03	0.22	0.22	
D33J013415.6+303744.3	3.914	21.99	22.80	0.48	0.78	
D33J013411.7+303547.1	3.933	21.88	22.41	0.20	0.26	
D33J013416.9+303610.9	3.933	21.54	21.90	0.18	0.19	
D33J013341.2+302856.4	3.970	21.25	21.97	0.13	0.20	1
D33J013337.0+303544.2	3.994	21.49	22.14	0.23	0.33	
D33J013338.8+303630.1	4.035	21.75	22.10	0.21	0.22	
D33J013411.7+303843.5	4.035	21.11	21.54	0.12	0.14	
D33J013357.9+302918.8	4.056	20.99	21.63	0.10	0.10	
D33J013336.7+303128.7	4.078	21.45	21.53	0.26	0.18	
D33J013357.9+303526.7	4.078	···	21.34	···	0.12	
D33J013337.3+303425.1	4.099	21.84	···	0.20	···	
D33J013357.3+303455.8	4.099	21.55	22.42	0.14	0.18	
D33J013346.7+303149.7	4.121:	21.35	22.07	0.13	0.24	

Table 4—Continued

Name	P $(days)$	$\langle V\rangle$	$\langle B\rangle$	A_V	A_B	Comments
D33J013355.9+303550.1	4.132	21.80	···	0.34	···	
D33J013345.2+303506.3	4.143:	21.59	22.64	0.19	0.40	
D33J013352.0+303137.2	4.187	···	23.11	···	0.76	
D33J013340.1+303642.3	4.233:	22.62	23.21	0.28	0.44	
D33J013336.4+303235.6	4.256:	20.88	21.63	0.12	0.13	
D33J013340.8+302920.2	4.256:	21.76	22.47	0.15	0.31	
D33J013342.1+303451.2	4.256	21.86	22.39	0.27	0.34	
D33J013337.4+303221.9	4.279	21.36	22.20	0.14	0.18	
D33J013348.8+303312.4	4.327	21.44	22.05	0.21	0.29	
D33J013400.6+303556.2	4.327	21.79	22.47	0.33	0.57	
D33J013405.7+303528.5	4.327	20.97	21.47	0.15	0.19	
D33J013413.2+303653.8	4.327	21.45	22.07	0.16	0.25	
D33J013337.1+303740.6	4.351	21.05	···	0.14	···	
D33J013352.9+303202.6	4.351	21.79	22.62	0.26	0.49	
D33J013354.3+303159.3	4.351	21.46	22.07	0.21	0.29	
D33J013336.9+303709.3	4.360	20.88	21.80	0.21	0.37	1
D33J013336.0+303305.0	4.375:	21.03	21.42	0.14	0.16	
D33J013406.2+303842.6	4.375	21.12	21.29	0.18	0.17	
D33J013414.8+303033.3	4.400	21.50	22.29	0.36	0.49	
D33J013332.3+303046.7	4.425:	21.94	···	0.21	···	
D33J013354.2+303205.5	4.425	22.16	22.81	0.42	0.57	
D33J013333.6+303002.9	4.450:	21.93	22.64	0.28	0.46	
D33J013352.9+303356.7	4.450:	21.25	21.89	0.13	0.13	
D33J013353.6+303001.3	4.450	21.50	22.27	0.29	0.36	
D33J013415.5+302942.3	4.502:	21.57	22.61	0.24	0.61	
D33J013341.7+302928.2	4.528:	21.94	22.57	0.22	0.31	
D33J013350.4+303216.3	4.528	21.62	22.06	0.20	0.23	
D33J013354.4+303523.6	4.528	21.45	22.04	0.14	0.22	
D33J013332.6+303526.1	4.581	20.89	21.55	0.12	0.19	
D33J013336.4+303645.7	4.608	···	22.61	···	0.50	
D33J013338.8+303819.2	4.608	20.83	21.38	0.14	0.17	
D33J013413.2+303315.1	4.608	21.48	···	0.16	···	
D33J013411.3+303823.9	4.636	22.22	22.68	0.44	0.46	
D33J013414.9+303612.8	4.636	21.48	21.96	0.17	0.22	
D33J013342.6+303104.9	4.692:	21.27	21.83	0.18	0.18	
D33J013355.7+303351.5	4.692:	21.44	22.25	0.28	0.46	
D33J013411.1+303853.7	4.720:	21.37	22.43	0.14	0.26	
D33J013350.9+303117.2	4.749	21.54	22.36	0.29	0.39	
D33J013352.0+303129.4	4.749	20.83	21.28	0.09	0.11	
D33J013356.2+303227.7	4.772	21.49	22.17	0.26	0.36	
D33J013337.5+303147.7	4.808:	21.46	22.13	0.19	0.20	

Table 4—Continued

Name	P (*days*)	$\langle V\rangle$	$\langle B\rangle$	A_V	A_B	Comments
D33J013343.3+303416.3	4.808	21.74	22.84	0.16	0.44	
D33J013345.5+303806.9	4.808:	21.81	22.19	0.29	0.46	
D33J013350.2+303212.1	4.808	21.64	22.38	0.26	0.37	
D33J013339.1+303713.3	4.840	21.37	22.27	0.35	0.60	1
D33J013348.8+303449.8	4.898:	21.52	21.89	0.16	0.14	
D33J013349.9+303231.8	4.898	21.99	22.57	0.25	0.33	
D33J013353.1+303251.9	4.898	21.95	22.38	0.32	0.32	
D33J013358.6+303830.3	4.898	21.52	22.60	0.28	0.60	
D33J013337.1+303060.0	4.929:	20.58	21.14	0.07	0.11	
D33J013342.9+302903.7	4.930	20.29	21.46	0.11	0.14	1
D33J013336.4+303437.8	4.980	21.43	22.09	0.34	0.34	1
D33J013335.1+303534.2	4.992	21.28	22.04	0.21	0.39	
D33J013335.4+303138.3	4.992:	21.98	22.63	0.19	0.21	
D33J013331.6+303407.1	5.025	21.55	22.50	0.30	0.45	
D33J013345.0+303001.3	5.025	21.17	21.70	0.14	0.15	
D33J013351.0+303118.2	5.025	21.60	22.18	0.45	0.52	
D33J013411.8+303743.1	5.025	21.84	···	0.33	···	
D33J013333.2+303349.3	5.057	21.65	22.46	0.37	0.43	
D33J013356.1+303223.1	5.090	21.46	22.32	0.30	0.51	
D33J013403.9+303808.4	5.090	20.67	21.16	0.18	0.26	
D33J013402.5+303601.0	5.124:	21.71	22.09	0.23	0.22	
D33J013417.5+303153.4	5.124	21.59	22.11	0.11	0.09	
D33J013352.3+303217.6	5.158	21.10	21.52	0.19	0.23	
D33J013355.5+303527.3	5.158:	21.42	21.90	0.25	0.36	
D33J013414.2+303530.6	5.158	22.50	···	0.45	···	
D33J013358.1+302958.6	5.240	21.09	21.88	0.20	0.27	1
D33J013405.9+303453.8	5.280	21.04	21.60	0.33	0.49	1
D33J013342.6+303329.5	5.310	20.66	21.30	0.14	0.15	1
D33J013408.6+303754.8	5.320	21.13	21.90	0.31	0.51	1
D33J013340.8+303434.3	5.330	21.26	21.47	0.40	0.63	1
D33J013335.9+303118.6	5.334:	20.99	···	0.17	···	
D33J013403.8+303830.5	5.334	21.04	22.02	0.30	0.49	
D33J013351.8+303450.0	5.371:	21.48	22.26	0.29	0.45	
D33J013354.3+303530.7	5.371	20.58	21.21	0.09	0.20	
D33J013355.7+303711.4	5.371	21.56	22.62	0.22	0.77	
D33J013342.5+302958.7	5.390	21.55	22.37	0.24	0.44	1
D33J013353.8+303212.0	5.408	21.14	21.41	0.21	0.20	
D33J013333.4+303118.2	5.446:	22.33	···	0.32	···	
D33J013349.5+303501.4	5.446:	21.27	22.06	0.19	0.31	
D33J013359.5+303846.8	5.450	21.05	21.79	0.32	0.48	1
D33J013416.2+303752.2	5.485:	···	21.21	···	0.13	

Table 4—Continued

Name	P (*days*)	$\langle V \rangle$	$\langle B \rangle$	A_V	A_B	Comments
D33J013351.3+303156.6	5.524	21.87	22.36	0.47	0.40	
D33J013400.5+303546.1	5.524:	22.06	23.05	0.25	0.50	
D33J013403.0+303805.4	5.531	21.19	21.88	0.26	0.40	
D33J013331.8+303727.2	5.540	21.93	22.51	0.42	0.55	1
D33J013357.0+303117.5	5.550	20.54	21.30	0.11	0.15	1
D33J013342.1+303712.5	5.563:	21.89	23.14	0.19	0.24	
D33J013351.2+303001.0	5.600	20.47	21.12	0.15	0.19	1
D33J013347.2+303622.0	5.603:	20.89	21.39	0.12	0.15	
D33J013406.2+303559.2	5.603	21.27	21.77	0.23	0.25	
D33J013343.1+303754.3	5.644:	· · ·	21.39	· · ·	0.09	
D33J013354.3+303215.9	5.720	· · ·	21.25	· · ·	0.18	
D33J013336.0+303306.2	5.769	20.70	21.45	0.11	0.21	
D33J013411.7+303504.7	5.769	21.71	22.12	0.22	0.19	
D33J013332.2+303001.9	5.790	21.20	21.87	0.34	0.40	1
D33J013333.8+303415.5	5.856:	21.45	· · ·	0.17	· · ·	
D33J013345.1+303838.5	5.856	20.85	21.07	0.30	0.25	1
D33J013350.9+303156.3	5.890	21.05	21.23	0.33	0.35	1
D33J013405.0+303557.5	5.890	21.10	21.88	0.29	0.52	1
D33J013407.3+303048.6	5.900	21.76	22.46	0.45	0.53	1
D33J013407.9+303831.6	5.900	20.60	21.26	0.22	0.33	1
D33J013335.8+303300.2	5.900:	21.25	21.86	0.13	0.11	
D33J013355.5+303152.3	5.900:	21.56	22.43	0.15	0.21	
D33J013356.5+303232.8	5.900:	21.18	21.68	0.11	0.10	
D33J013353.1+303217.5	5.945:	21.87	22.81	0.41	0.64	
D33J013359.8+303800.0	5.990	21.12	21.86	0.38	0.64	1
D33J013341.1+303453.8	5.991	21.18	21.70	0.30	0.36	
D33J013350.6+303445.8	6.030	21.13	21.96	0.26	0.43	1
D33J013354.4+303222.7	6.085	21.13	21.52	0.26	0.37	
D33J013402.9+303907.6	6.085	21.50	22.78	0.28	0.70	2
D33J013417.0+302923.1	6.110	21.23	21.94	0.51	0.54	1
D33J013406.2+303031.3	6.180	21.27	21.98	0.19	0.18	1
D33J013334.9+303735.3	6.181:	21.74	22.51	0.30	0.27	
D33J013352.3+303801.3	6.181	21.05	· · ·	0.33	· · ·	
D33J013404.9+303630.9	6.181	20.35	21.13	0.10	0.18	
D33J013402.9+303813.0	6.231	21.24	21.84	0.22	0.28	
D33J013417.0+303415.5	6.250	21.14	21.88	0.30	0.43	1
D33J013400.1+303904.2	6.281	21.10	21.87	0.35	0.51	2
D33J013343.2+303148.6	6.332:	21.54	21.98	0.35	0.36	
D33J013400.5+303630.8	6.332	21.00	21.77	0.28	0.45	
D33J013408.0+303845.7	6.332:	20.95	21.28	0.14	0.15	
D33J013335.6+303129.9	6.384	20.70	21.05	0.23	0.20	

Table 4—Continued

Name	P (*days*)	$\langle V \rangle$	$\langle B \rangle$	A_V	A_B	Comments
D33J013343.2+303243.2	6.436	20.66	20.93	0.20	0.19	
D33J013416.6+303858.5	6.436:	21.95	23.00	0.41	0.62	
D33J013346.3+303626.7	6.490:	20.58	21.18	0.07	0.09	
D33J013351.8+303310.6	6.490:	21.63	22.49	0.27	0.35	
D33J013333.2+303326.4	6.545:	21.00	22.09	0.12	0.16	
D33J013400.4+303251.6	6.545:	21.65	22.53	0.43	0.58	
D33J013410.9+303845.1	6.545:	21.58	22.66	0.41	0.67	2
D33J013338.5+303745.3	6.714:	20.99	21.95	0.11	0.18	
D33J013403.8+303731.9	6.714:	20.62	21.34	0.10	0.11	
D33J013404.5+303416.6	6.772	21.25	22.03	0.31	0.51	
D33J013349.4+303009.4	6.780	20.95	21.60	0.30	0.36	1
D33J013407.7+303851.1	6.832	21.37	22.13	0.29	0.42	
D33J013336.6+303416.7	6.954:	21.19	22.07	0.21	0.50	
D33J013402.8+303644.7	6.954	20.71	21.20	0.14	0.15	
D33J013355.7+303903.6	7.016:	20.99	21.39	0.12	0.14	2
D33J013332.5+303408.9	7.060	20.81	21.65	0.24	0.54	1
D33J013333.8+303427.8	7.060	20.73	21.55	0.18	0.30	1
D33J013337.9+303354.6	7.145:	21.06	21.84	0.26	0.34	
D33J013413.6+303027.7	7.300	21.22	22.01	0.23	0.17	1
D33J013335.9+303804.3	7.347	20.90	21.77	0.29	0.44	
D33J013359.0+303756.3	7.347	21.28	22.22	0.55	0.94	1
D33J013356.1+303803.9	7.350	21.32	22.18	0.35	0.70	1
D33J013347.4+303848.5	7.417	20.53	···	0.17	···	2
D33J013351.3+303227.1	7.417	21.16	21.75	0.26	0.33	
D33J013334.1+303311.0	7.489	21.67	22.53	0.29	0.30	
D33J013336.5+303053.2	7.590	20.88	21.62	0.44	0.43	1
D33J013353.2+303506.1	7.629:	21.20	22.01	0.24	0.38	
D33J013347.9+302943.6	7.630	21.11	21.96	0.29	0.38	1
D33J013356.5+303547.6	7.635:	21.49	22.30	0.16	0.32	
D33J013410.8+303834.8	7.635	21.50	22.41	0.27	0.51	
D33J013346.0+303747.0	7.711:	20.11	20.83	0.04	0.07	
D33J013358.6+303316.6	7.711:	20.73	21.36	0.30	0.46	
D33J013411.6+303255.0	7.711	21.12	···	0.26	···	
D33J013417.2+303726.1	7.720	21.82	22.77	0.50	0.82	1
D33J013352.5+303219.3	7.747	20.88	22.03	0.19	0.45	
D33J013350.7+303203.7	7.770	···	20.62	···	0.11	1
D33J013417.3+303211.5	7.960	20.94	21.38	0.40	0.31	1
D33J013332.4+303143.3	7.970	21.43	22.16	0.23	0.38	1
D33J013348.8+303415.8	7.970	20.56	21.20	0.27	0.41	1
D33J013405.4+303825.0	8.029:	21.07	21.65	0.24	0.26	
D33J013336.3+303243.7	8.180	21.24	22.03	0.23	0.29	1

Table 4—Continued

Name	P (*days*)	$\langle V \rangle$	$\langle B \rangle$	A_V	A_B	Comments
D33J013348.8+303045.0	8.180	21.11	21.91	0.15	0.21	1
D33J013402.4+303831.8	8.330	20.84	21.25	0.22	0.23	1
D33J013339.8+303412.2	8.370	20.83	21.69	0.33	0.49	1
D33J013338.9+303504.2	8.465:	20.83	21.44	0.28	0.34	
D33J013406.6+303816.8	8.580	20.55	21.29	0.29	0.44	1
D33J013401.6+303858.2	8.653:	20.54	21.37	0.39	0.60	2
D33J013343.5+303121.5	8.751:	20.85	21.64	0.16	0.22	
D33J013337.5+303305.1	8.980	21.27	21.84	0.25	0.39	1
D33J013339.0+303413.5	9.056	20.79	21.39	0.22	0.31	
D33J013336.8+303434.4	9.060	20.41	21.13	0.25	0.42	1
D33J013413.9+303212.3	9.090	20.83	21.55	0.26	0.31	1
D33J013346.3+302908.9	9.120	20.53	21.02	0.14	0.10	1
D33J013409.3+302956.8	9.162:	20.76	21.64	0.19	0.25	
D33J013352.7+303416.2	9.220	21.13	22.17	0.24	0.49	1
D33J013345.9+303749.5	9.272	20.93	21.83	0.24	0.32	
D33J013359.7+303720.9	9.383	20.64	21.30	0.13	0.15	
D33J013414.2+303713.8	9.498	21.04	21.55	0.25	0.27	
D33J013343.1+303648.9	9.590	20.67	21.48	0.23	0.32	1
D33J013402.1+303741.9	9.615	20.98	21.33	0.31	0.38	
D33J013349.2+303218.1	9.810	21.07	21.94	0.20	0.27	1
D33J013333.2+303344.5	9.985:	20.42	21.08	0.14	0.22	
D33J013355.0+303537.0	10.120	20.62	21.38	0.33	0.43	1
D33J013342.1+303210.7	10.380	20.73	21.96	0.25	0.87	1
D33J013356.1+303903.0	10.430	20.56	21.52	0.32	0.54	1
D33J013409.5+303621.6	10.470	20.57	21.46	0.27	0.58	1
D33J013338.8+303422.6	10.600	20.47	20.93	0.25	0.26	1
D33J013341.9+302951.8	10.600	20.99	22.06	0.19	0.54	1
D33J013335.6+303649.2	10.700	20.94	21.73	0.30	0.42	1
D33J013415.4+303727.6	11.280	21.19	21.89	0.43	0.35	1
D33J013411.3+303535.2	11.450	20.90	21.82	0.39	0.56	1
D33J013353.4+303308.5	11.490	21.24	22.07	0.43	0.62	1
D33J013335.5+303330.2	11.520	20.51	21.34	0.41	0.52	1
D33J013413.4+303317.7	11.520	21.20	22.16	0.31	0.42	1
D33J013336.3+303730.7	11.790	21.06	21.98	0.31	0.31	1
D33J013337.7+303218.9	11.880	20.88	21.66	0.19	0.27	1
D33J013357.6+303805.4	12.340	20.48	21.10	0.42	0.69	1
D33J013349.8+303758.7	12.910	20.39	21.32	0.44	0.69	1
D33J013350.0+303014.9	12.970	20.61	21.43	0.31	0.37	1
D33J013406.1+303734.0	13.020	20.89	21.93	0.18	0.33	1
D33J013411.9+302947.6	13.310	20.58	21.60	0.43	0.47	1
D33J013412.0+303519.1	13.370	20.83	21.73	0.55	0.78	1

Table 4—Continued

Name	P $(days)$	$\langle V \rangle$	$\langle B \rangle$	A_V	A_B	Comments
D33J013351.2+303758.2	13.560	20.14	20.98	0.33	0.48	1
D33J013402.5+303628.0	13.660	20.50	21.20	0.33	0.49	1
D33J013331.6+303704.5	13.760	20.87	21.97	0.29	0.30	1
D33J013338.8+303751.1	13.780	21.00	22.13	0.38	0.45	1
D33J013336.5+302933.5	13.940	21.27	22.51	0.20	0.51	1

Note. — (1) Variables identified by Macri et al. (2001a)
(2) Variables identified by Mochejska et al. (2001a)

Table 5. DIRECT Flux Cepheids in M33B

Name	P $(days)$	Comments
D33J013401.3+303907.9	3.218	
D33J013355.0+303214.3	4.099	
D33J013402.3+303855.0	4.210	2
D33J013408.5+303323.5	4.375:	
D33J013357.1+303212.8	4.635	
D33J013338.6+303757.4	4.692:	
D33J013416.5+303223.1	4.749	
D33J013351.0+303145.3	4.898	
D33J013408.6+303831.5	4.898	
D33J013415.4+303715.9	5.298:	
D33J013402.5+303845.0	6.132	
D33J013353.6+303151.4	6.231:	
D33J013416.7+303559.4	6.490:	
D33J013336.4+303228.4	7.211:	
D33J013353.4+303757.5	7.347:	
D33J013332.6+303115.1	7.867:	
D33J013357.3+303840.1	9.735	2
D33J013412.5+303839.8	11.240	1
D33J013339.5+303416.9	13.907	
D33J013346.1+303809.3	14.422	

Note. — (1) Variables identified by Macri et al. (2001a)
(2) Variables identified by Mochejska et al. (2001a)

Table 6. Light Curves of Cepheids in M33B

Name	Filter	HJD−2451000	flux	σ_{flux}
D33J013402.3+303855.0	b	452.7982	-78.865	116.725
	b	452.9166	71.067	157.887
	b	454.6968	395.685	122.487
	b	454.7299	335.538	91.812

Note. — Table 6 is available in its entirety in the electronic version of the Astronomical Journal. A portion is shown here for guidance regarding its form and content.

Table 7. DIRECT Other Periodic Variables in M33B

Name	P (*days*)	V^a	B^a	A_V	A_B	Comments
D33J013340.2+303722.2	1.98	19.41	19.32	0.12	0.07	EB
D33J013338.5+303113.3	2.01	20.82	20.61	0.58	0.42	EB
D33J013359.8+303354.9	2.11	17.91	17.85	0.10	0.12	
D33J013407.7+303454.7	2.18	19.14	19.06	0.03	0.04	
D33J013340.7+303054.5	2.32	20.55	20.54	0.06	0.03	
D33J013354.4+303357.4	2.78:	20.76	20.93	0.08	0.08	
D33J013410.6+303516.8	3.18	···	20.50	···	0.06	
D33J013332.5+303335.3	3.19:	19.44	19.26	0.10	0.05	EB
D33J013334.8+303211.4	3.40	···	···	···	···	1
D33J013356.9+303752.4	3.66:	20.29	21.15	0.06	0.13	
D33J013339.4+303124.6	3.69	16.98	···	0.01	···	
D33J013334.2+303058.0	3.71	21.23	21.65	0.21	0.29	1
D33J013416.9+303454.6	4.57	21.22	20.92	0.13	0.09	1
D33J013359.1+303523.9	4.66	···	20.75	···	0.10	
D33J013351.8+303159.7	4.73:	20.65	20.73	0.09	0.08	
D33J013354.8+303248.9	4.87	18.30	18.24	0.04	0.04	1
D33J013339.7+302942.9	4.93	21.04	21.38	0.13	0.15	1
D33J013341.6+303220.3	5.30	16.32	17.11	0.03	0.02	1
D33J013353.7+303519.6	5.81:	19.62	19.50	0.17	0.13	EB
D33J013341.8+303452.1	5.97	21.22	21.74	0.32	0.39	1
D33J013344.6+303145.5	6.08	19.42	19.40	0.03	0.04	
D33J013412.8+303840.1	6.18	···	19.87	···	0.05	
D33J013342.6+303603.3	6.23:	18.63	18.52	0.06	0.04	EB
D33J013356.5+303316.2	6.53	17.05	17.04	0.01	0.01	
D33J013413.7+303551.8	7.39	20.74	20.73	0.43	0.41	EB
D33J013352.0+303542.6	8.85:	···	19.36	···	0.03	
D33J013333.5+303320.5	9.01	···	···	···	···	1
D33J013347.8+303813.7	9.38	···	···	···	···	1
D33J013358.6+303241.8	9.62	19.79	20.06	0.14	0.15	
D33J013401.4+303727.1	12.56:	···	20.14	···	0.11	

Note. — [a] The V and B columns list the maximum magnitudes V_{max} and B_{max} for the eclipsing variables and flux-weighted average magnitudes $\langle V \rangle$ and $\langle B \rangle$ for the other variables.

(1) Variables identified by Macri et al. (2001a)

Table 8. Light Curves of Other Periodic Variables in M33B

Name	Filter	HJD−2451000	mag	σ_{mag}
D33J013340.2+303722.2	B	452.7982	19.354	0.004
	B	452.9166	19.337	0.006
	B	454.6968	19.394	0.005
	B	454.7299	19.357	0.004

Note. — Table 8 is available in its entirety in the electronic version of the Astronomical Journal. A portion is shown here for guidance regarding its form and content.

Table 9. DIRECT Miscellaneous Variables in M33B

Name	$\bar{V}$	$\bar{B}$	A_V	A_B	Comments
D33J013345.1+303619.8	16.56	17.11	0.06	0.05	1
D33J013401.8+303858.3	16.65	18.06	0.03	0.04	1
D33J013358.1+303320.7	16.67	16.78	0.07	0.05	LP
D33J013352.5+303816.0	16.77	17.63	0.04	0.09	1
D33J013338.1+303110.3	16.82	16.82	0.06	0.02	LP
D33J013339.3+303118.6	16.88	18.62	0.01	0.05	1
D33J013357.9+303302.4	16.89	···	0.03	···	
D33J013410.9+303840.9	16.93	17.45	0.07	0.08	
D33J013355.6+303500.7	17.00	17.56	0.11	0.12	LP
D33J013351.6+303454.7	17.01	17.11	0.05	0.04	LP
D33J013335.2+303559.9	17.08	17.20	0.03	0.05	1
D33J013416.4+303120.9	17.14	17.23	0.15	0.10	LP
D33J013344.2+303147.9	17.22	17.21	0.05	0.03	LP
D33J013344.1+303205.6	17.23	18.20	0.01	0.04	1
D33J013417.8+303327.1	17.25	17.23	0.06	0.05	LP
D33J013416.9+303856.8	17.26	···	0.06	···	
D33J013359.0+303353.7	17.27	17.33	0.06	0.04	LP
D33J013333.4+303407.3	17.28	17.34	0.03	0.03	LP
D33J013357.5+303306.4	17.30	···	0.04	···	LP
D33J013346.3+303257.3	17.34	17.57	0.04	0.03	
D33J013345.0+303616.8	17.42	17.41	0.05	0.06	LP
D33J013333.2+303505.7	17.52	17.60	0.03	0.03	1
D33J013400.9+303414.9	17.55	19.26	0.06	0.07	1
D33J013354.6+303308.1	17.56	···	0.08	···	LP
D33J013409.2+303423.2	17.64	18.45	0.05	0.08	1
D33J013350.6+303230.3	17.70	···	0.11	···	1
D33J013335.7+303842.8	17.79	···	0.10	···	LP
D33J013352.1+303636.5	17.79	18.03	0.04	0.04	LP
D33J013359.8+303427.1	17.79	17.73	0.05	0.03	
D33J013332.4+303543.3	17.80	17.73	0.05	0.07	LP
D33J013347.3+303306.5	17.80	17.84	0.05	0.06	LP
D33J013351.1+303811.1	17.80	···	0.10	···	LP
D33J013344.4+303843.9	17.83	17.99	0.04	0.04	LP
D33J013401.0+303634.7	17.84	17.99	0.04	0.02	LP
D33J013409.2+303853.1	17.85	18.12	0.11	0.08	LP
D33J013359.2+303535.2	17.89	17.91	0.04	0.06	LP
D33J013359.6+303333.0	17.91	18.11	0.04	0.03	LP
D33J013416.1+303641.8	17.91	17.93	0.06	0.06	LP
D33J013338.2+303818.9	17.93	17.93	0.07	0.04	
D33J013351.4+303848.8	17.93	18.03	0.09	0.08	LP
D33J013344.8+303217.5	17.94	18.04	0.03	0.03	LP

Table 9—Continued

Name	$\bar{V}$	$\bar{B}$	A_V	A_B	Comments
D33J013409.6+303638.2	17.94	17.95	0.07	0.05	LP
D33J013352.8+303819.4	17.97	17.98	0.09	0.08	LP
D33J013358.5+303419.8	17.99	19.69	0.05	0.05	1
D33J013415.2+303659.1	18.01	18.22	0.06	0.04	LP
D33J013350.4+303855.8	18.07	18.18	0.04	0.05	LP
D33J013350.4+303817.1	18.10	18.07	0.08	0.09	LP
D33J013341.3+303212.7	18.11	···	0.15	···	1
D33J013406.7+303631.4	18.18	18.23	0.04	0.03	LP
D33J013414.9+303436.4	18.28	19.09	0.10	0.15	
D33J013343.3+303318.6	18.30	···	0.09	···	1
D33J013359.5+303021.8	18.30	18.34	0.11	0.09	LP
D33J013349.9+302928.9	18.33	18.96	0.10	0.04	1
D33J013414.6+303326.6	18.36	19.02	0.06	0.06	
D33J013344.8+303210.8	18.41	18.58	0.03	0.02	LP
D33J013352.3+303746.2	18.44	18.53	0.06	0.06	LP
D33J013350.3+303226.0	18.46	18.51	0.06	0.04	LP
D33J013345.2+303138.2	18.50	20.36	0.12	0.15	1
D33J013340.1+303549.8	18.52	18.57	0.07	0.08	LP
D33J013336.7+303531.8	18.53	20.38	0.04	0.08	1
D33J013416.3+303353.4	18.58	20.46	0.26	0.20	1
D33J013340.0+303507.5	18.60	19.41	0.54	0.69	
D33J013357.2+303429.2	18.62	18.56	0.05	0.04	LP
D33J013356.8+303529.7	18.66	18.75	0.03	0.04	LP
D33J013401.6+303551.9	18.66	18.60	0.05	0.03	LP
D33J013355.6+303334.2	18.67	18.84	0.03	0.05	LP
D33J013349.8+303224.6	18.73	20.44	0.10	0.08	1
D33J013339.9+303810.4	18.76	18.64	0.07	0.05	LP
D33J013401.1+303010.9	18.77	18.73	0.07	0.04	LP
D33J013344.3+303635.7	18.81	19.12	0.06	0.03	1
D33J013357.8+303338.9	18.83	20.44	0.29	0.23	
D33J013344.6+303552.7	18.84	18.92	0.06	0.06	LP
D33J013341.2+303525.6	18.87	18.91	0.06	0.04	LP
D33J013344.1+303600.9	18.89	18.81	0.10	0.07	LP
D33J013400.5+303536.4	18.92	18.85	0.04	0.04	LP
D33J013411.5+303312.6	19.03	20.40	0.12	0.08	1
D33J013333.4+303350.7	19.05	20.98	0.09	0.11	1
D33J013353.0+303842.8	19.06	19.06	0.06	0.04	1
D33J013415.3+303633.5	19.06	18.93	0.10	0.07	LP
D33J013343.9+303800.7	19.10	19.10	0.06	0.04	LP
D33J013402.3+303828.3	19.21	21.00	0.08	0.08	1
D33J013353.5+303519.9	19.24	···	0.05	···	1

Table 9—Continued

Name	$\bar{V}$	$\bar{B}$	A_V	A_B	Comments
D33J013339.4+303512.4	19.25	20.93	0.04	0.06	1
D33J013357.0+303355.3	19.26	21.22	0.06	0.12	1
D33J013414.5+303557.7	19.28	21.16	0.05	0.08	1
D33J013331.5+303410.2	19.32	21.04	0.04	0.14	1
D33J013333.5+303149.2	19.32	20.95	0.10	0.10	1
D33J013335.5+303403.2	19.34	20.50	0.07	0.07	1
D33J013406.2+303808.1	19.35	19.64	0.09	0.09	
D33J013335.2+303040.6	19.40	20.98	0.05	0.06	1
D33J013338.8+303532.5	19.41	21.35	0.10	0.14	1
D33J013342.4+303631.0	19.42	21.31	0.13	0.16	1
D33J013412.2+303320.6	19.43	21.23	0.24	0.21	1
D33J013335.5+303015.3	19.44	21.14	0.20	0.15	
D33J013416.3+303158.6	19.44	21.14	0.05	0.08	1
D33J013351.2+303510.3	19.47	21.21	0.12	0.17	
D33J013356.2+303258.7	19.48	21.35	0.15	0.14	1
D33J013333.9+303402.6	19.50	21.11	0.12	0.13	1
D33J013350.5+303222.1	19.51	20.61	0.10	0.07	
D33J013405.4+303632.4	19.52	19.77	0.11	0.12	LP
D33J013403.6+303143.0	19.53	21.47	0.04	0.07	1
D33J013406.7+303430.0	19.53	21.33	0.16	0.20	
D33J013348.6+303247.8	19.56	19.79	0.10	0.10	LP
D33J013414.5+303511.5	19.56	21.11	0.05	0.09	1
D33J013339.0+303505.6	19.57	20.79	0.04	0.08	1
D33J013353.6+303210.6	19.58	21.31	0.05	0.09	1
D33J013352.1+303902.3	19.59	21.91	0.21	0.38	
D33J013412.9+303309.9	19.59	21.49	0.06	0.08	1
D33J013340.8+303236.1	19.62	21.40	0.11	0.11	
D33J013332.0+303338.0	19.64	21.11	0.11	0.09	
D33J013331.1+303502.4	19.68	21.19	0.08	0.13	1
D33J013359.1+303212.2	19.69	21.70	0.08	0.16	1
D33J013358.5+303812.8	19.72	21.46	0.17	0.14	1
D33J013401.2+303557.3	19.72	21.29	0.09	0.12	1
D33J013342.3+303608.0	19.73	21.58	0.17	0.15	1
D33J013348.8+303709.2	19.73	21.37	0.10	0.15	1
D33J013357.0+303516.9	19.73	21.79	0.06	0.16	1
D33J013352.4+303840.2	19.75	20.01	0.11	0.13	2 LP
D33J013343.5+302938.3	19.77	21.56	0.06	0.09	1
D33J013350.6+303617.1	19.79	21.49	0.05	0.07	1
D33J013351.4+303842.3	19.80	19.70	0.08	0.04	1
D33J013400.5+302951.5	19.82	21.32	0.33	0.20	1
D33J013335.9+303344.0	19.83	21.93	0.18	0.16	1

Table 9—Continued

Name	$\bar{V}$	$\bar{B}$	A_V	A_B	Comments
D33J013344.4+303227.7	19.84	21.69	0.12	0.13	1
D33J013357.4+303409.1	19.84	19.70	0.16	0.12	LP
D33J013345.1+303606.3	19.85	21.16	0.14	0.19	1
D33J013405.5+303443.2	19.86	21.57	0.09	0.13	1
D33J013407.7+303742.4	19.86	20.06	0.27	0.28	LP
D33J013342.6+303534.4	19.89	21.38	0.07	0.11	1
D33J013352.4+303736.4	19.90	21.48	0.25	0.20	1
D33J013359.4+303734.0	19.91	21.45	0.05	0.12	1
D33J013401.6+303129.0	19.95	21.89	0.13	0.14	1
D33J013401.5+303859.2	19.96	19.98	0.11	0.05	1
D33J013359.5+303200.3	19.98	···	0.11	···	
D33J013343.7+303134.1	19.99	20.22	0.14	0.13	LP
D33J013415.5+303107.3	19.99	21.11	0.20	0.26	LP
D33J013344.0+303609.5	20.01	···	0.08	···	LP
D33J013416.3+303801.6	20.04	21.73	0.20	0.15	1
D33J013345.7+303609.5	20.05	···	0.22	···	
D33J013355.1+303109.9	20.07	20.62	0.14	0.18	
D33J013334.4+303426.4	20.08	20.60	0.16	0.25	LP
D33J013354.3+303320.5	20.08	21.29	0.07	0.09	1
D33J013337.4+303752.5	20.09	20.72	0.18	0.18	LP
D33J013352.2+303646.6	20.09	21.86	0.20	0.24	1
D33J013339.0+303828.9	20.11	21.09	0.12	0.09	1
D33J013416.4+303545.8	20.13	20.22	0.20	0.14	LP
D33J013339.3+303049.4	20.14	20.41	0.04	0.04	1
D33J013348.9+303826.6	20.22	···	0.45	···	LP
D33J013350.5+303225.3	20.24	22.05	0.17	0.19	1
D33J013338.4+303638.9	20.26	21.24	0.36	0.71	LP
D33J013401.0+303432.2	20.31	22.05	0.09	0.16	1
D33J013332.8+303247.0	20.32	20.14	0.27	0.16	LP
D33J013354.6+303444.8	20.34	20.84	0.15	0.17	
D33J013351.4+303640.0	20.36	22.38	0.22	0.27	1
D33J013358.4+303429.4	20.42	21.16	0.58	1.16	LP
D33J013338.0+303235.6	20.51	22.06	0.20	0.16	1
D33J013406.1+303507.5	20.52	20.82	0.14	0.16	LP
D33J013417.8+303355.9	20.52	21.83	0.22	0.15	1
D33J013405.5+303418.9	20.53	20.91	0.10	0.11	1
D33J013349.3+303159.4	20.54	20.59	0.19	0.12	LP
D33J013409.7+303255.4	20.55	20.55	0.20	0.16	
D33J013333.4+303146.7	20.58	22.39	0.08	0.16	1
D33J013400.1+303755.8	20.59	20.61	0.22	0.14	
D33J013415.1+303655.8	20.60	20.82	1.11	1.04	LP

Table 9—Continued

Name	$\bar{V}$	$\bar{B}$	A_V	A_B	Comments
D33J013342.2+303640.7	20.62	21.17	0.24	0.12	
D33J013416.5+303728.6	20.63	21.47	0.60	0.79	LP
D33J013345.5+303521.3	20.67	22.03	0.19	0.18	
D33J013340.4+303131.1	20.69	···	0.11	···	1
D33J013357.7+303235.1	20.70	22.30	0.48	0.37	1
D33J013405.6+303905.4	20.70	21.73	0.44	0.33	
D33J013414.1+303609.4	20.74	21.32	0.22	0.31	
D33J013345.2+303444.1	20.77	22.11	0.28	0.25	
D33J013411.4+303125.8	20.78	20.68	0.21	0.13	LP
D33J013401.2+303423.1	20.81	20.64	0.21	0.17	
D33J013339.1+302944.1	20.82	22.57	0.15	0.45	1
D33J013340.1+303136.5	20.86	21.49	0.74	0.61	LP
D33J013331.3+303354.9	20.90	21.75	0.38	0.44	LP
D33J013350.7+303844.6	20.91	20.87	0.35	0.12	
D33J013356.1+302944.1	20.93	21.00	0.10	0.07	1
D33J013359.7+303111.0	20.96	22.08	0.22	0.26	
D33J013414.6+303723.0	20.96	22.40	0.25	0.29	
D33J013405.9+303819.4	20.97	21.83	0.56	0.79	LP
D33J013336.5+303650.2	21.01	22.36	0.56	1.24	LP
D33J013351.6+303653.4	21.02	22.26	0.46	0.48	
D33J013351.7+303815.8	21.02	21.99	0.23	0.25	
D33J013407.5+303648.3	21.04	21.06	0.27	0.30	
D33J013340.0+303201.1	21.05	···	0.17	···	1
D33J013353.8+303815.2	21.05	22.03	0.72	0.47	
D33J013404.3+303749.1	21.12	22.56	0.36	0.65	
D33J013336.1+303458.6	21.17	23.10	0.52	0.83	
D33J013345.6+303300.1	21.20	···	0.14	···	1
D33J013411.2+303748.4	21.22	22.59	0.35	0.45	
D33J013357.6+303249.5	21.23	21.24	0.31	0.22	
D33J013358.6+303245.7	21.24	22.60	0.27	0.20	
D33J013338.0+303540.0	21.26	22.96	0.58	0.68	
D33J013341.7+303405.7	21.26	···	0.34	···	
D33J013403.8+303753.0	21.27	22.31	0.29	0.23	1
D33J013341.1+303742.9	21.29	23.14	0.29	0.65	
D33J013356.6+303818.2	21.30	22.87	0.78	0.76	
D33J013410.8+303146.5	21.31	22.18	0.30	0.28	LP
D33J013338.5+302909.7	21.32	22.67	0.35	0.64	
D33J013345.0+303700.8	21.34	···	0.88	···	
D33J013347.5+303751.0	21.34	···	0.24	···	
D33J013403.7+303045.5	21.35	21.49	0.32	0.33	
D33J013335.8+303123.1	21.40	22.11	0.37	0.14	

Table 9—Continued

Name	$\bar{V}$	$\bar{B}$	A_V	A_B	Comments
D33J013343.1+303747.7	21.45	22.52	0.33	0.25	
D33J013357.5+303349.6	21.45	22.00	0.40	0.19	
D33J013333.1+303314.1	21.47	22.79	0.62	0.37	
D33J013338.2+303629.4	21.47	22.49	0.61	0.44	
D33J013344.5+303813.8	21.47	···	0.66	···	
D33J013401.5+303438.9	21.47	22.43	0.54	0.34	
D33J013409.6+303559.5	21.47	22.93	0.45	0.54	LP
D33J013350.3+303526.3	21.50	24.38	0.35	1.30	1
D33J013341.6+303854.5	21.52	20.17	0.35	0.07	LP
D33J013339.5+303649.0	21.55	···	0.53	···	LP
D33J013408.7+303224.0	21.56	22.68	1.35	0.86	
D33J013336.1+303835.9	21.59	···	0.55	···	
D33J013357.4+303620.1	21.59	22.88	0.51	0.55	
D33J013348.6+303842.2	21.62	···	0.40	···	
D33J013410.5+303510.6	21.63	···	0.67	···	
D33J013336.0+303801.1	21.64	22.50	0.48	0.28	
D33J013346.2+303109.9	21.64	22.56	0.89	0.37	
D33J013415.3+303808.7	21.64	22.28	0.57	0.19	
D33J013345.3+303449.8	21.66	···	0.81	···	
D33J013333.2+303516.9	21.68	23.18	1.71	1.72	
D33J013402.4+303513.1	21.68	22.94	0.61	0.80	
D33J013354.4+303210.2	21.69	21.72	0.33	0.26	
D33J013412.2+303241.6	21.71	23.17	0.58	0.53	1
D33J013335.0+303056.6	21.72	22.71	0.90	0.49	
D33J013339.7+303003.9	21.72	23.53	0.66	0.83	
D33J013342.3+303153.1	21.72	···	0.72	···	
D33J013353.0+302904.1	21.76	23.12	0.75	0.97	
D33J013404.5+303315.4	21.77	23.66	0.71	0.96	1
D33J013409.4+303800.4	21.77	22.52	0.80	0.28	
D33J013343.8+303116.7	21.80	···	0.40	···	
D33J013346.7+303851.0	21.82	···	0.51	···	
D33J013346.3+303556.1	21.86	22.92	0.61	0.49	
D33J013333.5+303624.4	21.88	···	0.77	···	
D33J013404.3+303018.5	21.89	23.33	0.73	0.58	LP
D33J013408.2+303705.5	21.89	23.30	0.70	0.54	
D33J013401.3+303501.1	21.90	23.23	0.44	1.12	LP
D33J013409.8+303652.2	21.91	···	1.39	···	
D33J013402.7+303656.7	21.92	22.90	0.91	0.46	
D33J013408.0+303210.2	21.92	···	0.48	···	
D33J013350.2+303712.6	21.96	···	0.85	···	
D33J013337.1+303337.2	21.98	22.20	1.28	0.35	

Table 9—Continued

Name	$\bar{V}$	$\bar{B}$	A_V	A_B	Comments
D33J013402.5+303256.5	21.98	⋯	0.36	⋯	
D33J013334.3+303856.0	22.00	⋯	1.76	⋯	
D33J013355.4+303259.4	22.00	23.27	0.97	0.75	
D33J013338.2+303438.9	22.05	23.35	1.47	1.38	
D33J013406.4+303042.0	22.05	23.47	0.48	0.50	
D33J013406.9+303759.6	22.05	⋯	0.60	⋯	
D33J013335.2+303653.1	22.06	23.55	1.02	0.84	
D33J013403.2+303838.2	22.06	23.25	0.85	0.58	
D33J013358.7+303450.5	22.07	⋯	0.96	⋯	
D33J013342.7+303137.3	22.13	23.04	1.49	0.84	
D33J013401.4+303753.8	22.14	⋯	0.70	⋯	
D33J013405.9+303733.1	22.16	23.08	1.01	0.60	
D33J013336.7+303836.0	22.21	23.17	0.51	0.51	
D33J013353.8+303028.2	22.23	⋯	1.45	⋯	
D33J013343.2+302903.3	22.25	⋯	1.46	⋯	
D33J013338.4+303135.5	22.27	⋯	0.71	⋯	
D33J013416.6+303300.2	22.27	⋯	0.73	⋯	
D33J013339.3+303033.1	22.29	22.91	1.60	1.26	LP
D33J013409.3+303357.7	22.30	23.22	1.39	0.90	
D33J013344.3+303334.0	22.32	⋯	1.10	⋯	
D33J013406.7+303128.6	22.33	23.92	1.07	0.94	
D33J013355.9+303744.0	22.38	⋯	1.42	⋯	
D33J013334.1+302956.5	22.41	⋯	1.17	⋯	
D33J013414.8+303753.8	22.41	⋯	1.05	⋯	
D33J013353.9+303635.6	22.44	24.46	1.07	1.10	
D33J013346.8+303721.4	22.45	23.84	1.28	1.64	
D33J013357.3+303811.5	22.45	⋯	1.91	⋯	
D33J013412.4+303350.1	22.45	⋯	1.34	⋯	
D33J013335.9+303644.6	22.49	⋯	0.87	⋯	LP
D33J013349.4+303853.3	22.49	⋯	1.56	⋯	
D33J013358.3+303055.1	22.50	23.72	0.74	0.69	
D33J013359.0+303315.3	22.52	⋯	1.68	⋯	
D33J013402.1+302946.3	22.53	23.50	0.96	0.41	
D33J013415.0+303517.2	22.55	⋯	1.89	⋯	
D33J013353.8+303145.5	22.56	⋯	1.25	⋯	
D33J013338.3+303224.1	22.60	⋯	0.88	⋯	
D33J013413.2+303251.1	22.60	23.29	0.74	0.65	
D33J013404.0+303046.2	22.61	⋯	0.94	⋯	
D33J013353.2+303237.0	22.62	⋯	0.86	⋯	
D33J013404.5+303257.0	22.66	23.61	0.87	0.71	1
D33J013335.4+303157.1	22.67	⋯	0.98	⋯	

Table 9—Continued

Name	$\bar{V}$	$\bar{B}$	A_V	A_B	Comments
D33J013416.8+303214.9	22.68	···	1.39	···	
D33J013415.9+302919.2	22.69	23.46	0.87	0.44	1
D33J013347.3+303646.0	22.72	···	1.19	···	
D33J013349.4+303423.0	22.77	23.76	1.26	0.81	
D33J013350.6+303133.8	22.87	···	1.30	···	
D33J013417.6+303649.9	22.89	···	1.36	···	
D33J013411.4+303224.4	22.92	23.96	1.32	1.01	
D33J013334.8+302930.4	22.93	···	1.13	···	
D33J013338.8+303312.9	22.93	···	1.61	···	
D33J013345.6+303704.8	22.96	23.60	1.28	0.68	
D33J013355.3+303832.5	23.21	···	2.07	···	
D33J013333.1+303756.6	23.23	···	1.42	···	
D33J013413.3+303133.1	23.32	24.31	1.08	1.06	
D33J013405.2+303653.9	23.43	···	2.19	···	
D33J013331.4+303407.5	···	···	···	···	
D33J013332.2+303016.9	···	···	···	···	LP
D33J013333.8+303854.8	···	23.05	···	0.52	
D33J013334.4+303011.0	···	···	···	···	
D33J013334.8+303835.7	···	···	···	···	1
D33J013335.0+302912.3	···	···	···	···	
D33J013335.2+303406.0	···	···	···	···	
D33J013335.4+303829.8	···	···	···	···	
D33J013335.8+303038.4	···	22.67	···	0.25	
D33J013336.0+303359.4	···	···	···	···	
D33J013336.5+303111.8	···	···	···	···	
D33J013336.5+303339.0	···	···	···	···	
D33J013336.6+303154.3	···	···	···	···	LP
D33J013336.7+303505.7	···	···	···	···	
D33J013338.3+303739.2	···	23.64	···	0.77	
D33J013339.1+303536.0	···	···	···	···	
D33J013339.5+303824.5	···	21.39	···	0.30	
D33J013339.7+303827.5	···	···	···	···	
D33J013339.8+303451.9	···	···	···	···	1
D33J013341.1+303717.0	···	···	···	···	
D33J013342.2+303747.0	···	20.43	···	0.93	LP
D33J013342.5+303718.4	···	···	···	···	
D33J013342.6+303300.5	···	···	···	···	
D33J013342.7+303146.5	···	···	···	···	LP
D33J013342.7+303805.0	···	···	···	···	
D33J013342.9+303234.4	···	···	···	···	1
D33J013343.9+303735.8	···	22.41	···	0.28	

Table 9—Continued

Name	$\bar{V}$	$\bar{B}$	A_V	A_B	Comments
D33J013345.2+303437.0	···	···	···	···	
D33J013345.2+303547.4	···	···	···	···	
D33J013345.4+303823.1	···	···	···	···	
D33J013345.9+303620.0	···	···	···	···	
D33J013346.4+303822.7	···	21.60	···	0.20	
D33J013346.7+303902.5	···	···	···	···	
D33J013346.9+303522.6	···	···	···	···	
D33J013348.9+303530.2	···	···	···	···	
D33J013349.5+303822.4	···	22.66	···	0.28	
D33J013349.9+303838.6	···	···	···	···	LP
D33J013349.9+303852.2	···	19.14	···	0.07	LP
D33J013350.5+303654.8	···	24.55	···	1.69	
D33J013350.6+303842.5	···	19.45	···	0.05	
D33J013350.7+303158.4	···	···	···	···	
D33J013351.8+303849.1	···	18.05	···	0.07	
D33J013351.9+303529.1	···	···	···	···	
D33J013352.0+303152.8	···	22.32	···	0.81	LP
D33J013352.5+303903.1	···	···	···	···	
D33J013352.8+303602.2	···	···	···	···	
D33J013353.0+303200.9	···	···	···	···	
D33J013353.0+303759.3	···	···	···	···	LP
D33J013353.0+303815.2	···	···	···	···	
D33J013353.5+303823.9	···	18.52	···	0.10	LP
D33J013354.2+303721.2	···	···	···	···	LP
D33J013354.8+303815.1	···	···	···	···	
D33J013354.9+303450.6	···	···	···	···	
D33J013355.5+303400.0	···	···	···	···	
D33J013356.0+303834.7	···	20.05	···	0.04	1
D33J013356.5+303604.0	···	22.84	···	0.28	
D33J013356.5+303812.1	···	···	···	···	
D33J013356.8+303430.2	···	···	···	···	LP
D33J013356.9+302949.4	···	···	···	···	
D33J013357.0+303818.0	···	21.14	···	0.22	1
D33J013357.1+303559.3	···	···	···	···	
D33J013357.2+303837.9	···	21.42	···	0.15	
D33J013357.6+303844.0	···	···	···	···	2 LP
D33J013357.8+303717.9	···	20.84	···	0.16	1
D33J013358.1+303235.2	···	···	···	···	
D33J013359.7+303753.2	···	···	···	···	
D33J013401.7+303601.1	···	18.34	···	0.02	LP
D33J013401.9+303908.3	···	···	···	···	

Table 9—Continued

Name	$\bar{V}$	$\bar{B}$	A_V	A_B	Comments
D33J013402.0+303901.2	···	22.66	···	0.54	
D33J013402.1+303836.0	···	···	···	···	
D33J013402.9+303316.8	···	22.17	···	0.26	
D33J013402.9+303754.2	···	18.84	···	0.04	LP
D33J013403.4+303649.3	···	18.39	···	0.06	
D33J013405.4+303719.2	···	20.62	···	0.21	1
D33J013405.6+303119.6	···	23.43	···	0.40	
D33J013407.8+303334.5	···	22.66	···	0.47	
D33J013408.5+303631.5	···	···	···	···	
D33J013409.3+303414.4	···	18.77	···	0.07	LP
D33J013409.4+303706.2	···	···	···	···	1
D33J013409.6+303908.0	···	21.34	···	0.15	1
D33J013409.7+303829.9	···	23.70	···	0.92	
D33J013410.3+303710.0	···	···	···	···	
D33J013410.9+303437.5	···	16.09	···	0.08	1
D33J013411.1+303659.5	···	···	···	···	LP
D33J013413.8+303337.3	···	···	···	···	
D33J013415.2+303207.5	···	···	···	···	
D33J013415.3+303404.6	···	···	···	···	LP
D33J013415.3+303804.3	···	···	···	···	
D33J013416.1+303808.0	···	18.97	···	0.04	
D33J013416.3+303712.3	···	···	···	···	LP

Note. — (1) Variables identified by Macri et al. (2001a)
(2) Variables identified by Mochejska et al. (2001a)

Table 10. Light Curves of Miscellaneous Variables in M33B

Name	Filter	HJD−2451000	mag	σ_{mag}
D33J013352.4+303840.2	B	452.7982	19.995	0.009
	B	452.9166	19.987	0.012
	B	454.6968	20.040	0.011
	B	454.7299	20.040	0.009

Note. — Table 10 is available in its entirety in the electronic version of the Astronomical Journal. A portion is shown here for guidance regarding its form and content.